The Lower Carboniferous Corals of Australia

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Plates VII.-XI. and Seven Text-Figures.

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CONTENTS.

INTRODUCTION.

This paper revises, where possible, those species of Australian Lower Carboniferous corals already erected, and describes several new species collected by the author. It deals with the "*Naos*" modification of septa in these and other Rugose corals; and describes skeletal malformation in an Australian Viséan coral. It also gives a brief summary of our present knowledge of the Lower Carboniferous stratigraphy of Australia, and a note on variation in Rugose coral species.

The work was begun at the University of Queensland, and completed at the Sedgwick Museum, Cambridge, by the author while she held consecutively the Open Scholarship for Scientific Research and the Foundation Travelling Scholarship of the University of Queensland, and the Old Students' Research Fellowship of Newnham College, Cambridge. She wishes to record her gratitude to the authorities concerned in these awards, and to thank Miss G. L. Elles, Dr. Stanley Smith, Dr. W. D. Lang, Mr. A. G. Brighton, Dr. H. D. Thomas, Dr. F. W. Whitehouse, Dr. W. H. Bryan, Mr. W. S. Dun and Mr. J. S. Fletcher for a great deal of assistance. She is glad to state that publication was made possible by grants from the Commonwealth of Australia

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Genus SYMPLECTOPHYLLUM gen. nov.

Symplectophyllum, from συμπλεκτος, woven; φιλος, a leaf, that is a septum.

Genotype.—*Symplectophyllum mutatum* sp. nov. from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland.

Diagnosis.—Simple Rugose corals with a very variable axial structure involving septa and tabulae. The septa are dilated in their early stage, but later the median part may become cavernous, and the peripheral breaks down into horizontal tissue and consists of long narrow convex plates connected by granules of stereome. The tabulae, although sometimes complete, are usually incomplete. The dissepiments are small, and rather elongated, but do not enter the periphery of the coral. Stereome is irregularly developed.

Remarks.—The genus is interesting for two reasons; first, it shows a type of septal modification like that seen in the Silurian genus *Naos* Lang (1926, p. 428), and permits an explanation of such a structure; second, amongst the varying expressions of its axial structure it shows patterns reminiscent of those which Thomson (1883, pp. 436 seq.) regarded as diagnostic for his Scottish Viséan genera *Rhodophyllum*, *Aspidiophyllum*, *Dibunophyllum*, *Kumatiophyllum*, *Centrephyllum* and *Carcinophyllum*.

SYMPLECTOPHYLLUM MUTATUM sp. nov. (Plate VII.)

Holotype:—F 2943, consisting of 8 slides and 4 pieces; in the University of Queensland Collection. (Plate I., figs. 1-6.)

Diagnosis.—As for genus.

Description.—External characters: Large simple corals usually with a long conico-cylindrical adult stage, sometimes turbinate. The largest specimen (broken at both ends) was 13 cm. long with a maximum diameter of 3 cm. The average adult diameter is 2.5 cm. The epitheca is thick, with faint annulations and striations.

Internal structures—Immature stage: Transverse sections of immature stages were obtained from only four corals. These, illustrated in Plate VII., figs. 6, 9, 16, and 27, show similarity in septal characters, diversity in the structure of the large axial area, and diversity in the amount of stereome present. The *septa* are dilated[1] and crowded. (Plate VII., fig. 27 shows 24 of each order at a diameter of 7 mm.). The minor septa are from half to two-thirds as long as the major, which usually attain a length of only one-third the diameter of the corallite, since they are very seldom continuous with the septal lamellae of the axial structure. Septal dilation[2] always occurs; in one section (fig. 27) it is so pronounced that the interseptal loculi are closed. *Dissepiments* are already present in these sections, although in fig. 27 they are entirely masked by stereome dilating the septa. The *axial area*, whose diameter is about one-third that of the corallite, may have its component plates entirely masked by stereome (fig. 27),

(1) Seen microscopically, the septa are pinnately fibrous.

(2) Whilst the septa when examined by a lens appear well defined and separate from the darker investing stereome which may fill the interseptal loculi, under the microscope they and the darker stereome are seen to merge into one another and their fibres are optically continuous.

diameter 7 mm.) ; it is known from transverse section only and may show sections of tabulae and dilated, discrete septal ends, variously arranged, with much (fig. 9, diamater 7 mm.) or little (fig. 6, diameter 12 mm.) stereome ; or it may be occupied only by one or two semicircular sections of tabulae about a dilated median lamella continuous with two opposite septa (fig. 16, diameter 6 mm.). The nature of the tabulae at these stages is unknown.

Adult stage : At a diameter of about 2 cm. the coral is mature. The septal characters are diagnostic, but the structure of the axial area whose diameter is 0.25 to 0.35 that of the corallite, is very variable.

The *septa* are crowded and dilated with stereome. They are pinnately fibrous, and though when examined by a lens they appear well defined and separate from the darker investing stereome which may fill the interseptal loculi, under the microscope they and the darker stereome are seen to merge into one another and their fibres are optically continuous. The major septa are usually discontinuous with the septal lamellae of the axial area, and the minor septa are 0.5 to 0.75 as long as the major. Axially both orders of septa are normal, and evenly thickened. In the median parts of the more dilated septa there seems to have been a tendency for the irregular deposition of the septal stereome, for caverns of irregular outline are left in the septum (*see* Plate I., figs. 28 and 30). When these are left along the plane of the septum it appears split, and in them dissepiments may arise. The boundary between the median parts of the septa and the investing stereome is often very irregular. Peripherally the dilated contiguous septa (which are essentially the vertical elements of the coral skeleton) break down into tissue with the character of horizontal skeletal elements.[1] The horizontal nature of this tissue is best seen in vertical section (Plate I., figs. 2, 11, 13, 22 and 25). In each septum this tissue consists of a large number of thin closely packed transverse plates, very long in the direction of elongation of the dissepiments ; *i.e.*, they have been deposited at successive levels of the peripheral calical floor. Some of them are axially continuous with dissepiments. They are thin and evenly arched upwards, and are sparsely and irregularly connected one to another by granules of stereome, which may sometimes unite to form short rods[2] piercing a few plates at right angles (Plate I., fig. 8). Since peripherally each septum was so dilated in the young stage as to be in contact with its neighbours, the equivalent series of plates in the adult stage are also in contact. Some of the plates of a series are grouped, and these groups are continuous with groups from the next series. Sometimes the relics of the median part of a septum are seen buttressing or even piercing the inner plates of a series, but usually the two zones of septal modification are discontinuous and a ring of coarse dissepiments is developed between them (Plate I., figs. 1, 10 and 14). Rarely, at points of septal insertion, one short major and two short minor septa are developed in the place of one minor septum. All three correspond to only one peripheral series of transverse plates, so that this septal modification had occurred before septal insertion had been completed (*See* septa at A, Plate I., fig. 1).

(1) The horizontal nature of this tissue was first pointed out to me by Dr. Stanley Smith.
(2) These represent the vertical rods described in the Silurian *Naos* by W. D. Lang (1926).

Stereome is always present, varying in amount and position. Plates originating as vertical tissue, *i.e.*, the septa and the septal lamellae of the axial structure are usually much dilated by the growth of all their pinnately arranged fibres into the interseptal loculi, so that the latter may become closed. Although the fibres of the septa and of the dilating stereome are continuous, there is a change in the direction of their deposition at the boundary of the septa, so that due to refraction of transmitted light the boundary of the septum appears as a dark line, and the dilating or investing stereome appears darker than the septa themselves. In the case of horizontal tissue, *i.e.*, dissepiments and tabulae, stereome may be deposited between the vertical elements (sometimes continuous with the fibres of the latter) on the upper surfaces and upper surfaces only of a series of dissepiments and tabulae representing all or part of a particular calical floor ; and such deposition may be recurrent.

Dissepiments are numerous, small, rather elongate and steeply inclined ; they do not occur between the septal modifications at the periphery but where the septa fail immediately within this peripheral zone one or two more or less continuous rings of large dissepiments may be developed. (Plate I, figs. 1, 10 and 14).

The *tabulae* form with the *septal lamellae* a very variable *axial structure.* The septal lamellae, which are usually twisted and discontinuous with the septa proper, are variously developed ; and on this variation depends the nature of the tabulae and the pattern of the axial structure. If the lamellae are few, they are usually irregular in course and discontinuous vertically ; and the tabulae then tend to be complete and broadly domed. Axial structures reminiscent in transverse section of those Thomson (1883, pp. 463-83) considered diagnostic of *Aspidiophyllum*, *Kumatiophyllum*, *Centrephyllum* and *Rhodophyllum* result (Plate I., figs. 1-13 and 19). But the few lamellae may attain a rough dibunophylloid arrangement, and the tabulae are then more steeply domed and less complete (Plate I., figs. 15-18). When the lamellae are more numerous they are usually strongly twisted and continuous vertically. The tabulae are then incomplete and the arrangement is histiophylloid. (Plate I., figs. 14 and 26). Stereome is common in the axial structure (*see* Plate I., figs. 20-26), and is usually developed when numerous lamellae are present, and the pattern is then carcinophylloid. All these, and intermediate patterns may occur in the one individual, as a study of Plate I. shows, but usually one type is predominant.

Remarks.—The *material* used in this study consisted of 20 individuals all from the same locality and horizon, and from which over 100 slides and surfaces have been cut. The corals appear to have grown in place, and are encrusted by fine growths of calcareous algae. Owing to the massive unweathered nature of the fine grained grey limestone matrix, no individuals with tips were collected, and no photographs of external form could be made.

The species is a variable one, and variation occurs in shape, amount of stereome present, pattern of the axial structure, the occurrence of caverns in the median parts of the septa, and the degree of development of the peripheral modification of the septa into transverse tissue. Variation in shape cannot be correlated with any other character. Gerth (1921) in his studies on the Permian corals of Timor showed that there long thin forms were comparatively free from stereome, while the short stout forms were very stereoplasmid; but in these Queensland Viséan corals there is no such connection.

Variation in the amount of stereome present is most striking in this species, and all other variations except that in shape appear to be in some degree dependent on it. The young corallite is very stereoplasmid, but becomes less so with growth. After such a disappearance stereome may again be deposited at one or more horizons, varying in amount and position (Plate VII., figs. 2, 22 and 25). The holotype is not very stereoplasmid, but F 2511 is a typical example (Plate VII., figs. 21-23). This discontinuous deposition cannot be correlated with any change in diameter of the coral, such as might be expected were it a rejuvenescence character.

Variation in the pattern of the axial structure is extreme as described above, and is dependent on the amount of stereome present and the development of the septal lamellae. A consideration of all slides and surfaces shows that there is no progressive transition from one type to another ; such changes as occur do so suddenly, and with the possibility of reversion, so that no particular pattern is of specific value.

Caverns occur in the median parts of the septa only if the septa concerned were previously dilated.

Peripheral dilation of the septa seems to be necessary before the peripheral series of transverse plates can be developed ; but when stereome has dwindled from the corallite these series can still be seen developed to the width of the earlier dilation of the septa ; their derivation from the vertical elements is not then obvious, and they look like modifications of the dissepimental tissue (Plate VII., fig. 10). Septa are secreted in invaginations in the base of the polyp, and the floor tissue (tabulae and dissepiments) by the flatter parts of the base. Should the invaginations become wide enough and shallow enough, the tissues they secrete will resemble floor tissue. This seems adequate as an explanation of the *Naos* type of modification. The connecting granules of stereome probably represent secretions from the more active points of calcification in the invagination. The rods seen in *Naos* and occasionally in *Symplectophyllum* represent the simple trabeculae secreted behind such active points of calcification.

Genus AMYGDALOPHYLLUM Dun and Benson.

Amygdalophyllum Dun and Benson, 1920, pp. 339-341.
Genotype.—*Amygdalophyllum etheridgei* Dun and Benson, 1920, pp. 339-341, Pl. xviii, figs. 2-6 non fig. 1[1].

Diagnosis.—Simple, conical or cornute Rugose corals with a wide fine-tissued dissepimental area, and typically with numerous long straight septa, a remarkably large solid columella, and incomplete tabulae. Rare diphymorphic[2] individuals may occur.

(1) Benson and Smith (1923, footnote p. 161) state that the original of fig. 1 proved when cut to be a specimen of *Zaphrentis sumphuens* Etheridge fils., which externally resembles *A. etheridgei.*

(2) A diphymorph (*see* Smith and Lang 1930) of a columellate coral is a group of individuals in which the columella fails, the septa retreat from the axis, and the tabulae flatten or become distally arched. The phaceloid forms have parricidal gemmation.

Remarks.—As so defined the genus is known only from the Lower Carboniferous (Viséan) of South Eastern Queensland and North Eastern New South Wales; but its relations with the British Lower Carboniferous *Koninckophyllum magnifivum* Thomson are being investigated. Each species of *Amygdalophyllum* shows a superabundant secretion of calcium carbonate, seen in the large solid columella and the dilated septa. When the septa are so dilated peripherally as to be in contact, they sometimes show the interesting type of modification to horizontal tissue typical of *Symplectophyllum*. But in *Amygdalophyllum* this modification is not seen in all the possible septa of one individual, nor in all the individuals of one species, nor in all the species of the genus. The genus therefore sheds light on how a trend in septal modification may be expressed.

AMYGDALOPHYLLUM ETHERIDGEI Dun and Benson.

Amygdalophyllum etheridgei Dun and Benson, 1920, pp. 339-341 and Pl. xviii, figs. 2-6 non fig. 1[1].

Amygdalophyllum etheridgei Dun and Benson; Benson and Smith 1923, pp. 161-5; Pl. viii, figs. 1-3; Pl. ix, fig. 2.

Holotype—A.M. 1311 (figured Benson and Smith, pl. ix, fig. 2) and syntypes A.M. 1132 and A.M. 1133 (Benson and Smith, pl. viii, fig. 3) in the collection of the Australian Museum, Sydney, Sections R22072 from the holotype and R21997 from a syntype, in the British Museum.

Diagnosis.—Large *Amygdalophyllum* with very numerous dilated septa; major septa confluent with the columella; minor septa unusually long; columella extremely large, fibrous, elliptical and cuspidate in section; tabellae small, sub-equal.

Remarks.—The species is known only from the original locality in mudstones of the Burindi Series (Viséan) at Babbinboon, N.S.W, For adequate description, *see* Benson and Smith, 1923, pp. 161-5. Pl. viii., figs. 1-3; Pl. ix., fig. 2.

AMYGDALOPHYLLUM INOPINATUM (Etheridge fil.) (Plate VIII., figs. 1-8).

Koninckophyllum inopinatum Etheridge fil., 1900, pp. 20-21, Pl. 1, fig. 2; Pl. ii, figs. 9 and 10.

Koninckophyllum inopinatum Etheridge fil.: Benson and Smith 1923, p. 161.

Lectotype.—(Here chosen) F 1606 in the collection of the Geological Survey of Queensland, the original of Etheridge's Pl. ii, fig. 9, from the Upper Viséan limestone of Lion Ck., Stanwell, near Rockhampton, Queensland.[2]

Diagnosis.—Large *Amygdalophyllum* with very numerous septa; major septa reaching almost to the columella, but not confluent with it; columella lenticular cupsidate in section, narrower than in *A. etheridgei*.

Description.—The corallum is robust, conical or turbinate, straight, sometimes with a slightly curved and flattened or spreading base of attachment (*see* Plate VIII., fig. 8). Average dimensions of type material: height 3.5 cm., diameter 3 cm. of Riverleigh specimens height 4 cm., diameter 3 cm., with a large[3] individual, incomplete, 7 cm. in height,

(1) *See* footnote 1, p. 67.

(2) This specimen was the only one of Etheridge's syntypes that I was able to find in August, 1932.

(3) Under constant favourable conditions there would seem to be no limit to the size attainable by any corallum; for the skeleton is formed by accretion from the polyp, which has unlimited growth; *i.e.*, it continues growing though usually at a constantly diminishing rate until it dies or, if a sexually reproducing, divides.

and 4.5 cm. in maximum diameter. Calice with a round everted margin, probably shallow. Epitheca thin, annulate.

The septa are very numerous and vary in number in different individuals. Specimens from the type locality show a variation between 42 and 99 septa of each order, and the Riverleigh specimens between 52 and 64. In the Riverleigh specimens the septa also vary in strength of development, *e.g.*, they may be dilated in the tabulate area (*see* Plate VIII., fig. 1). The major septa extend almost to the columella where their axial edges may be turned aside. They are seldom if ever confluent with it. In specimen E 2952 from Riverleigh this incipient diphymorphism has progressed to further withdrawal of the septa from the axis and discontinuity in the columella. The minor septa are seldom more than half the length of the major and are thinner. Indeed in F 2491 from Riverleigh in which the septa are very tenuous, the minor septa occasionally fail leaving the dissepiments between the major septa arranged in an irregular herring-bone pattern (Plate VIII., fig. 4). This specimen shows a weak development of the *Naos*[1] trend in that the septa and dissepiments in parts of the periphery are replaced by continuous series of *Naos*-like horizontal tissue of closely packed plates, but these are not connected by granules of stereome.

Dissepiments are numerous; those near the tabulae are small and steeply inclined but towards the periphery they become less steeply inclined and rather elongate. Discontinuity in the septa (usually the minor) of some Riverleigh specimens is complementary to the development of large dissepiments on which the septa are represented as crests. As the discontinuity is peripheral it is regarded as a weak expression of the lonsdaleoid[2] trend. The tabulae are incomplete and domed. The axial tabellae are large and broadly arched upwards and outwards and are supplemented near the dissepimental zone by smaller plates concave upwards and outwards.

The columella is oval and extends the entire length of the corallite in the Stanwell forms, but in the Riverleigh specimens it is usually less strongly developed and may be oval, elliptical or plate-like in section, or rarely, discontinuous vertically.

Distribution.—The species is known only in South Eastern Queensland, from the Upper Viséan limestones. In addition to the type locality (*supra*) it occurs in the Riverleigh limestone on Latza's Farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera.

Remarks.—Structurally this species might be regarded as *A. etheridgei* in which an incipient expression of the diphyphylloid trend has resulted in the comparative withdrawal of both orders of septa from the axis, and in the weaker development of the columella. On the other hand it is quite possible that a strongly columellate form like *A. etheridgei* could be derived from one less strongly columellate. The two species are widely separated geographically. Variation in *A.*

(1) The *Naos* trend is here defined as a tendency for stereome dilated septa to break down peripherally into horizontal tissue in the form of numerous fine convex plates transverse to each septum, the plates being connected by granules of stereome whose perfect arrangement is in rods normal to the plates. But for a full description of this trend and its expression *see* pp. 76-78.

(2) The lonsdaleoid trend is one in which the septa withdraw from the periphery.

inopinatum is great, especially in the Riverleigh specimens, as seen above, in size, number of septa, dilation of septa and amount of modification due to the very weak and sporadic expression of the diphyphylloid, lonsdaleoid and *Naos* trends.

Amygdalophyllum conicum sp. nov.

(Plate II., figs. 14-48 and Text-fig. 1).

Holotype.—A slide on which are mounted 8 sections of E 36 (Plate II., figs. 14-21).

Text-Figure 1.

Amygdalophyllum conicum sp. nov.

Paratype F2435 in the University of Queensland collection. Natural size.

Paratypes.—F 2445 (4 slides and 1 piece) shows (Plate II, figs. 37-40) the maximum development of Trend (1) (*vide infra*).

F 2942 (8 slides) shows (Plate II, figs. 41-48) the maximum development of Trend (2) (*vide infra*).

F 2437 (4 slides with 10 serial sections, and 1 piece) shows (Plate II, figs. 22-31) the same of Trend (3) (*vide infra*).

All types are in the University of Queensland Collection, from the Upper Viséan Riverleigh limestone of Latza's Farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, Queensland.

Diagnosis.—Short straight conical *Amygdalophyllum* with deep conical calyx and small columella. Before dissepiments arise, the major septa are straight, confluent with the columella, and slightly and evenly dilated. Adult appearance is variable due to the differential expression of three common trends ; (1) septal dilation, chiefly peripheral, (2) peripheral modification of these dilated septa to horizontal tissue, and (3) withdrawal of the septa fron the periphery.

Description.—External characters : The corallum is a straight cone (Text-fig. 1) or subturbinate ; the adult individuals show great constancy in size—height about 4 cm., and diameter about 2 cm. ; the conical calyx is from 1 to 2 cm. deep. When the septa are dilated or modified to transverse tissue, they form flat stripes on the calical floor widening towards the periphery. Otherwise they rise from the floors as thin bars. Epitheca faintly striated, thick, and irregularly annulate.

Internal structures : In the youngest stage observed, diameter 2 mm., the septa are arranged pinnately, coalescing at the centre ; the cardinal fossula is very large, and the transverse tissue is represented by simple tabulae only (Plate II., fig. 41). This pinnate stage has been called in other corals the zaphrentoid. With the appearance of rudimentary minor septa, the pinnate symmetry gives place to radial, and the well developed major septa coalesce axially with a distinguishable columella. The minor septa then lengthen and dissepimental tissue arises. This is the last stage in which all the individuals are identical.

In fully mature corals some characters are common to all individuals, but there is variation due to the sporadic expression of three common trends. Common characters are these: There are about 30 septa of each order, the minor septa being about half the length of the major, which show a tendency to withdraw from contact with the columella (Plate II., figs. 16-21). The columella is small but continuous vertically, and lenticular or ellipsoidal in section. The tabulate are incomplete, and slope up towards the columella; the tabellae are convex upwards and outwards and of unequal size, those abutting on to the columella being larger. When the septa are withdrawn from the columella the tabellae tend to become flat. Superimposed on these common characters are the modifications due to the sporadic expression of three trends. The first of these is the dilation of the septa; this may be peripheral so that the septa are in contact there (Plate II., figs. 37-40), or in the tabulate area (Plate II., fig. 33). The second, the *Naos* trend, is expressed by the modification of some of the dilated septa which are in contact peripherally, into horizontal tissue. In each septum this consists of numbers of fine convex transverse plates connected by granules of stereome or vertical relics of the septa. The transverse plates of one septum may be continuous with those of the next (Plate II., figs. 46-48). The third, the lonsdaleoid trend, is expressed by the withdrawal first of the minor, and later of the major septa also, from the epitheca, the septa being represented as crests on the dissepiments (*see* Plate II., figs. 22-24, 33, 36, 40, 46-47). These three trends may be expressed in different degrees in the same individual.

Remarks.—The 66 slides from 22 specimens, all from the same locality and horizon (*supra*) form a very complete and very convincing example of the extreme variation possible in individuals of one species due to the differential expression of common trends. Such a species may be called a variable species.

AMYGDALOPHYLLUM sp. near CONICUM Hill.

(Plate II., figs. 49-50).

Specimen F 2449 (2 slides and 4 pieces) in the collection of the University of Queensland from the Upper Viséan Riverleigh limestone of Latza's Farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland, probably represents a *forma* of *Amygdalophyllum conicum*, which is abundant at the same locality and horizon.

Description.—External characters: The specimen consists of a large hysterocorallite or rejuvenescence bud arising centrally from a broken mature calyx, the diameter of the bud at origin being 15 mm., while that of the parent is 25 mm. The bud continues for 4 cm., where it is broken across. It is then of oval section, the longer diameter being 25 mm., and the smaller 20 mm. The bud of this individual is thus larger than the average mature individual of *A. conicum.* The epitheca is thin and probably discontinuous.

Internal structures: The septa are of two orders, 30 in each cycle. The major septa are usually in contact with the columella and the minor septa are half their length. Both orders are dilated to the shape of a wedge, and in contact peripherally. The *Naos* trend is strongly developed, for where the septa are in contact they often become modified into horizontal tissue consisting of numbers of thin convex plates as wide as the septum, in contact or continuous with others from the neighbouring septum. In each septum these plates are connected by granules of stereome, irregular in position or in series forming rods normal to the plates, or by vertical relics of the septum. Not all the dilated septa are so modified. In vertical section these transverse modifications are seen to be continuous axially with dissepiments. Dissepiments are developed between major and minor septa where these are not in contact. They are of moderate size, very elongate, and the steepness of their inclination increases with their distance from the periphery. They may become very large and strongly developed when the septa (whether modified or not) become discontinuous. The tabulae are incomplete; the tabellae immediately about the columella tend to be flattened and larger than the rest which are irregular in size and inclination. Most of the tabellae seem crushed and broken. The columella is very irregular in outline, of variable strength of development, but usually small, and may fail completely.

Remarks.—This corallite differs from *A. conicum* only in its rejuvenescence, its larger size and the stronger development of the *Naos* trend.

AMYGDALOPHYLLUM VALLUM sp. nov. (Plate II, figs. 9–13).

Holotype.—F 2950 (4 slides and 2 pieces) from the Upper Viséan Riverleigh limestone of Latza's Farm, Portions 21 and 22, Parish of Nalmoe, County of Yarrol, near Mundubbera, Queensland, in the collection of the University of Queensland. (Plate II, figs. 9-11).

Diagnosis—Small trochoid *Amygdalophyllum* with regularly dilated short[1] septa, fine regular dissepiments, wide tabulate area and strong oval fibrous columella.

Description.—The corallum is robust, straight and conical, height and diameter each about 20mm. The epitheca is thin and annulate. The septa are of two orders, straight and regularly dilated so that they are approximately equal in width to the interseptal loculi, slightly tapering axially. The major septa are short, extending little over half way towards the axis; the minor septa are about half this length. The dissepiments are very small, regularly arranged in thin concentric rings, steeply inclined. The tabulae are incomplete, with tabellae of two series of equal radius; the inner series consists of large plates only slightly inclined upwards and outwards over most of their course; but at the columella they arch vertically to take part in its construction, and at their peripheral edges they bend sharply downwards; they may occasionally reach the dissepiments, but usually the small more highly arched outer tabellae separate them from the dissepiments. The columella is widely oval, solid, an independent rod not buttressed by axial septal ends, and is formed by the coalescence of the up-arched edges of the inner tabellae.

Remarks.—The interest of this species lies in the septa being short while the columella remains very strongly developed; and in the columella being formed by the up-arched axial edges of the inner tabellae. The shortness of the septa is obviously not due to lack of available calcium carbonate, for the septa themselves are dilated. Three specimens only are known, all from the type locality.

([1]) Short septa are those which have withdrawn from the axis.

Genus APHROPHYLLUM Smith.

Aphrophyllum Smith, 1920, pp. 53-55.
Genotype.—Aphrophyllum hallense Smith, 1920, pp. 53-55, Pl. ii, figs. 1-5.

Diagnosis.—Large Rugose corals, either compound (massive with imperfectly contiguous corallites), or growing in groups which might not be true colonies. The corallites are usually laterally compressed with long major septa which reach or nearly reach the axis. At maturity the septa withdraw from the periphery. The tabulae are broadly domed and incomplete.

Remarks.—The genus is known only from the Viséan of South Eastern Queensland and North Eastern New South Wales.

APHROPHYLLUM HALLENSE Smith (Plate IX, figs. 3–5).

Aphrophyllum hallense Smith, 1920, pp. 53-55, Pl. ii, figs. 1-5.
Holotype.—A.M. 1038 from F 17648 from the Viséan Burindi Series of the Parish of Hall, 16 miles south of Bingara, New South Wales, in the Australian Museum, Sydney; figured Smith 1920, Plate ii, figs. 1, 3-5; part of the holotype is A 5051 in the Sedgwick Museum.

Diagnosis.—Massive *Aphrophyllum*, corallites imperfectly contiguous, turbinate, with average diameter 15 mm.; septa not crowded; peripheral zone of dissepiments up to one third the radius of the corallite, inconstant.

Description.—The corallum is compound, massive. The corallites are imperfectly contiguous, partly rounded or imperfectly polygonal turbinate and laterally compressed. The largest corallite has a diameter of 20 mm.; the average diameter is 15 mm. Gemmation is lateral. The septa rarely show a radial arrangement since the corallites are laterally compressed. They are dilated and wedge-shaped, varying in number between 20 and 32 of each order. The major septa reach or nearly reach the axis; their axial edges are sometimes turned aside or may be twisted together to form an axial structure. The minor septa are seldom more than half the length of the major. The dissepiments of the interseptal loculi are small, regular and steeply inclined; but the horizontal tissue which frequently separates a group of the septa from the epitheca is less steeply inclined, and consists usually of coarse dissepiments convex upwards and inwards, but sometimes of broad flat close-lying platforms. These are thin and very wide, each being continuous transversely for some distance round the corallite, and continuous axially with ordinary interseptal dissepiments. The peripheral zone of transverse tissue need not extend all round the corallite; frequently only one half or one quarter of any given transverse section is affected by the peripheral failure of the septa. It is often crushed. The tabulae are broadly domed, thin, and very numerous; as many as 30 have been counted in 1 cm. They are irregularly interrupted by axial septal ends and are consequently usually incomplete. They may be supplemented[1] by smaller plates at the dissepimental wall. Layers of stereome may be deposited on the upper surface of the horizontal tissue, especially at the junction of the dissepiments with the tabulae.

Distribution.—The species is known only from New South Wales, where in addition to the type locality it occurs in the Viséan Burindi limestones in a quarry at Taree.

(1) Jones (1932, p. 60) distinguishes two series of tabellae. I do not consider his outer series constant or characteristic enough to be diagnostic.

Remarks.—The resemblance of the species to *Endophyllum abditum* Edwards and Haime has been noted by Smith (1920, p. 55) and Jones (1932, p. 60). The occurrence in it of the thin, closely packed and very wide peripheral platforms is probably an expression of the *Naos* trend, although here this transverse tissue has not been traced back to prove modification of dilated septa. Similar tissue occurs in the other species of this genus, and there it can be shown to have arisen from *Naos*-like modifications of the septa.

APHROPHYLLUM FOLIACEUM sp. nov. (Plate IX, figs. 6–16, text-fig. 2).

"*Palaeosmilia retiformis* Eth. fil. MS" F. W. Whitehouse MS, quoted J. H. Reid 1930, p. 35.

Holotype.—F 2430 in the collection of the University of Queensland, from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland; text-fig. 2.

TEXT-FIGURE 2.

Aphrophyllum foliaceum sp. nov.

Holotype F2430 in the University of Queensland collection. ½ diameter.

Diagnosis.—Large *Aphrophyllum* probably compound but possibly only very gregarious simple corals ; peripheral zone of dissepiments very wide, up to two-thirds the radius of the corallite.

Description.—External characters : The corallites occur in large numbers close together and may be imperfectly contiguous ; they are probably compound, but no budding has been observed. The corallites are large, very rapidly expanding to a diameter of 60 to 80 mm. (text-fig. 2, Plate III, figs. 6–8) ; they may remain squat and broadly turbinate, or grow to a great height, the maximum height observed being 240 mm. The tall weathered out specimens give the appearance of a number of funnels of nearly equal diameters placed in a concentric series at irregular distances apart, owing to the discontinuous development of the peripheral zone of dissepiments. The calyx is deep, with domed floor and everted margin (*see* Plate III, fig. 16). Epitheca is usually not preserved, thin.

Internal structures : Immature stages : A series of surfaces obtained by grinding down a tip showed that septal insertion occurs in the usual four positions, but is accelerated in the counter quadrants. The insertion of minor septa is according to the plan described by S. Smith (1913, p. 62) for *Aulophyllum*. The outline of the immature stages is usually, but not always, ellipsoidal. The plane of elongation always coincides with the cardinal and counter septa ; but the halves so divided are not mirror images, even in the number of the septa. The septa are pinnately fibrous in microscopic structure and are only slightly and evenly thickened. The major septa extend from the periphery towards the plane of elongation ; and in the more compressed corallites their axial edges may be inclined towards the cardinal and counter septa. The minor septa remain very short.

Adult stages : The corallite matures when its peripheral zone of coarse dissepiments arises. Its outline becomes more nearly circular, but the septate area remains faintly elongate in the plane of the cardinal and counter septa. The major septa are of unequal length, and extend straight towards the axis, their arrangement being thus more radial than in the young stages. Opposite their axial edges short lamellae which in transverse section resemble small paliform lobes may arise ; or the edges may be turned aside, or twisted together to form an inconstant axial structure. The minor septa are usually half as long as the major, but rarely and sporadically the two orders become almost equal in length (Plate III, fig. 12). The septa may be continued towards the epitheca as crests on the coarse peripheral dissepiments. They may sometimes be dilated, and the dilation may be regular, or rarely so irregular that they no longer have plane sides (Plate III, fig. 12). In parts of two specimens, a *Naos*-like modification of peripherally dilated septa has occurred, and in vertical sections the peripheral transverse tissue is seen to consist of numbers of closely packed platforms, continuous transversely, but which still indicate their derivation from the septa by the curves opposite the parent septa. They are however unconnected vertically by stereome (Plate III., figs. 6, 7, and 13).

The dissepiments of the interseptal loculi are small and steeply inclined, but those of the peripheral zone are usually very large and elongated in planes approaching the horizontal. This tissue is developed in alternately wide and narrow zones as if by rejuvenescence. The strong basal platform of each wide zone is possibly epitheca and grows out from the septate area at a uniformly widening angle. On it smaller elongate dissepiments are laid down till a horizontal surface is attained, when the process begins again. At times these coarse dissepiments are replaced by transverse tissue derived by *Naos*-like modification of the septa, as described above. The tabulae are broadly domed but incomplete, being interrupted by the axial ends of the major septa; they may also be reinforced centrally by smaller domed tabellae. They are closely packed, as many as 20 being counted in 1 cm.

Distribution.—About 20 specimens were collected from the type locality. The species is also represented by three rolled and broken specimens from the Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, and possibly one from Old Cannindah Homestead, near Monto, Queensland.

Remarks.—In the strong lateral compression of the area with septa and in the wide peripheral zone of dissepiments, this species is reminiscent of *Humboldtia* Stuckenberg (1895, p. 224) and *Keyserlingophyllum* Stuckenberg (1895, p. 219) from the Dinantian of Russia. But the types of these genera are inaccessible so that a discussion of their relations with *Aphrophyllum* is not possible. The species is of interest in the acceleration of septal insertion in the counter quadrants, and in the sporadic expression of the *Naos* trend.

While what are probably paliform lobes are common in two of the three Lion Ck. specimens and infrequent in the Riverleigh specimens, the character is not considered of specific value, since some individuals in a corallum of the compound *A. hallense* show such lobes while others do not.

The Expression of a Trend towards Septal Modification in Certain Rugose Corals.

(Plates I, II, and III).

Certain Rugose coral individuals which occur in the Upper Viséan limestone of Riverleigh[1] in Queensland have in common a particular modification of their septa. This is a peripheral modification of septa which have been very much dilated by stereome, particularly where such dilation has caused the peripheral closing of interseptal loculi. The replacing tissue in each septum consists of a stack of thin plates convex upwards and inwards, as wide as the septum was thick. They are elongated parallel to the peripheral part of the calical floor, *i.e.*, parallel to the inclination of true dissepimental tissue. This character suggests that they represent horizontal tissue, and when it is seen, that axially groups of them are continuous with dissepiments, and that laterally also groups are either continuous with groups in neighbouring septa directly, or rarely through a narrow dissepiment, there can be no doubt that they are horizontal tissue replacing the dilated vertical septum. Vertical continuity is attained by granules of stereome connecting two successive plates and not by rods at right angles to the plates; though very rarely, these granules may be arranged one above the other so that extremely short rods are formed. In explanation of the origin of this modification we may note that

(1) On Latza's farm Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland.

peripheral dilation of the septa till they are almost or quite in contact seems to be necessary before the peripheral series of plates can be developed. Septa are secreted in invaginations in the base of the polyp, and the floor tissue (tabulae and dissepiments) by the flatter parts of the base. Should the invaginations become wide enough and shallow enough, the tissue they secrete will resemble floor tissue; and this seems adequate explanation. The connecting granules of stereome probably represent secretions from the more active points of calcification in the invagination. Any rods would represent the simple trabeculae secreted behind almost normally active points of calcification.

Such a modification can be used as a generic character in *Symplectophyllum* Hill since it affects in varying degree some or all of the septa at maturity. In this genus the median parts of the dilated septa may become cavernous; but this phenomenon cannot be seen to have any causal connection with the peripheral modification to horizontal tissue (Plate I).

This modification is also known as *Amygdalophyllum* Dun and Benson. But here it is known in only two of the four species, and in neither is it diagnostic, since it occurs sporadically at maturity in only two individuals of *A. conicum* Hill and one of *A. inopinatum* (Etheridge). In *A. conicum* it arises in dilated contiguous septa (Plate II); but whether this is so in *A. inopinatum* cannot be ascertained, since the earlier parts of the corallite are broken off. In the former the details are clear and well executed; but in the latter the execution seems to have been much rougher.

The third genus occurring at this locality and showing this modification is *Aphrophyllum* Smith. Two of about 20 individuals of *A. foliaceum* Hill show it sporadically in dilated septa not quite in contact (Plate III). None of the remaining genera occurring at this locality show the trend, although septal dilation does occur in them.

It is seen in a third individual of *A. foliaceum* occurring at a different locality on the same horizon—the Lion Ck. limestone at Stanwell, Queensland, while the New South Wales species of *Aphrophyllum*, *A. hallense* Smith, occurring in two localities[1], also shows this modification. In the New South Wales species, however, the plates of neighbouring septa are continuous in platforms, and curves denoting each septum in these continuous platforms are flattened out, while the connecting stereome granules disappear. The appearance of finished craftsmanship is thus lost, and the details appear only roughly sketched.

Thus there is in Carboniferous corals at various localities in Eastern Australia a tendency or trend for dilated septa to become modified peripherally in mature parts of the corallum into horizontal tissues vertically connected by stereome granules. The expression of the trend can in one case be used as a generic character, but is otherwise quite sporadic, and may be found with much minuteness and exactness of detail or only roughly sketched out. While the septa affected are always strongly dilated, it does not seem absolutely necessary that they should be in contact. In their unmodified condition these septa were pinnately fibrous. The above corals are the only ones known to me to

(1) 16 miles south of Bingara, Parish of Hall, N.S.W.; and Quarry at Taree, N.S.W.

show this curious modification in the Carboniferous. *Nagatophyllum* Ozawa (1925, pp. 78-80, Pl. xii, figs. 1–5) from the Dinantian of Japan would seem from the figures to have septa peripherally modified into similar stacks of transverse plates, but without examination of the actual material I cannot be sure.

In the Middle Devonian of Torquay, England, '*Chonophyllum perfoliatum*' auctt. shows sporadically a somewhat similar peripheral modification of dilated septa into horizontal tissue. Here the zone affected is very wide, and the septa are not always in contact; the stacks of plates formed are kept in vertical continuity by short rods at right angles to the horizontal tissue. In this species the structure is often masked by thin smears of the stereome of the dilated septa remaining unmodified (Plate III, figs, 17–19). French's figure of *Cyathophyllum tinocystis* (1885, p. 28, Pl. i, fig. 1), from the lower Upper Devonian of Grund, shows this type of modification. The forms from the Lower Devonian of Bohemia which were placed by Pocta (1902, p. 111) in the genus *Chonophyllum* show similar modifications. In America (Canada West) this modification in the Devonian species *Naos magnificus* (Billings) has been described by Scherzer (1892, pp. 259–62, Pl. viii, fig. 5).

In the Silurian (Niagaran) of Arctic America, the genus *Naos* Lang (1926, p. 428) shows a perfect development. Here the horizontal tissue is widely spaced and replaces dilated septa separated by narrow dissepimental alleys, and vertical continuity is attained by long strong vertical rods at right angles to the transverse tissue (well figured by Lang op. cit. Pl. xxx, figs. 1–3). Since this genus shows the most perfect development of the modification (for in later occurrences the highly developed vertical rods tend to be represented by granules of stereome), the trend might be called the *Naos* trend.

In its sporadic occurrence and varying degree of perfection it resembles any other trend in corals, whether such a trend affects only vertical or horizontal elements or both. The sporadic development of this septal structural trend deserves emphasis. The governing factor seems to be neither chronological nor systematic; and although the septa must be strongly dilated before the modification can arise, it is not a necessary result of such dilation. The unmodified septa are of the ordinary pinnately fibrous type in *Symplectophyllum*, the only one where the microscopic structure is known.

Skeletal Malformation in an Australian Carboniferous Coral.

Plate III, figs. 1–2.

A fragment[1] of a large simple Rugose coral from the Upper Viséan limestone of Riverleigh[2] in Queensland shows undoubted skeletal malformation. This obscures the tissue of the axial area and affects groups of septa in increasing degree. Because of its malformation it is impossible to say with certainty to which species the coral belongs, but its septal, dissepimental and outer tabulate structures are like those of *Amygdalophyllum inopinatum* (Etheridge), which is common at the same locality.

(1) F 2465 in the University of Queensland Collection; a part of this is A 5064 in the Segdwick Museum.

(2) Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland.

Description.—The fragrant of corallite was slightly curved, about 8 cm. long, expanding from a diameter of about 3.5 cm at the bottom to 4.5 cm at the top, where it was slightly compressed.

The unaffected parts of the corallite show the following internal structures. The septa are thin, leaf-like and crowded, about 66 of each order. The major septa are long, extending into the axial area, where they are masked by malformation. The minor septa attain half this length. The dissepiments are numerous, elongate, and not very regular ; the inner ones are smaller and more steeply inclined than the outer. Only a little of the outer part of the tabulate area is not malformed, but it can be seen that the tabulae are incomplete and that often two series of plates, an inner and an outer, are present. The outer series consists of numerous flat-lying concave plates. It is absent when the inner dissepiments are so steeply inclined as to be almost vertical and thus to form a wall on to which the tabellae of the inner series then abut directly. These are large, convex and steeply arched upwards towards the axis. It is impossible to say whether they abutted originally on to a columella, or merely formed a dome as in *Palaeosmilia.*

Malformation affects an increasing area in the corallite. In the lowest part of the fragment it is pronounced in the axial area and in a group of septa forming a segment 6 mm. in width at the epitheca ; a second, smaller group in which five septa are malformed extends from the axial area not quite to the epitheca. The area of these two affected sepments increases with the age of the corallite, while a third group of septa also becomes involved, the malformation rapidly spreading outwards from the axial area to the epitheca. On the upper surface of the fragment, fully half of the corallite is malformed. The malformed structures and also the adjacent normally developed elements are often macerated.

In each of the affected areas normal development of the vertical and horizontal elements of the coral skeleton no longer takes place. The first stage is the dilation of the septa with stereome starting from the axial ends until interseptal loculi are practically absent. Then these dilated vertical elements become discontinuous, or extremely tortuous in course, or even suppressed altogether. The normal horizontal tissue is entirely suppressed, but in the irregular loculi formed by the discontinuity or suppression of the dilated vertical elements, widely spaced uncurved plates may arise, which may or may not be horizontal.

The stereome is deposited as a lining to the septa (usually on both surfaces but sometimes on one only) and occasionally on the upper surface of horizontal tissue. Microscopic investigation of the stereome rarely shows traces of fibrosity such as one associates with the normal deposition of a coral skeleton. Mostly it appears granular or non-fibrous ; but as frequently in normally formed dilated septa the fibrosity is masked by the state of preservation, it cannot be assumed that this stereome differs in any way from that which dilates normal septa. Bands of dark spots may be discerned running parallel to the surface which the stereome is lining. This is a common condition in *Caninia.*

Remarks.—It is idle to speculate on the nature of the adverse conditions causing the malformation ; but it is important to note that here the deposition of stereome linings is without doubt due to adverse conditions. Whether stereome deposited in adverse conditions differs in structure from that deposited under normal conditions is not arguable on the ambiguous evidence given by this specimen. A series of experiments on and subsequent sections of modern corals would give the best approach to this problem. I hope to undertake work on these lines in the future.

Genus CARCINOPHYLLUM Thomson.

Carcinophyllum Thomson 1881, pp. 241-244.

Genotype.—Carcinophyllum kirsopianum Thomson[1] 1881, pp. 243-4; text-fig. 3 on p. 241, and Pl. ii, figs. 7, 7a, and 7b, from the Lower Carboniferous of Arbigland, Dumfries, Scotland.

Diagnosis.—Simple or dendroid Rugose corals, with a central column in which the septal lamellae are dilated, irregular, and anastomosing, and a mesial plate is present. The septa dilate towards the periphery of the corallum, and form a stereozone; but through most of the corallum they are separated from the epitheca by coarse dissepiments. The tabulae between the central column and the dissepiments are widely spaced, and are flat or sagging.

Remarks.—In the British representatives of this genus, the peripheral stereozone is scarcely ever perfect owing to the excessive development of the lonsdaleoid trend; but in the Australian species the stereozone is infrequently broken through, and that at maturity only.

Carcinophyllum patellum sp. nov. (Plate IV, figs. 1–17).

Holotype.—F 2534 (2 slides and 3 pieces) in the University of Queensland collection, from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Plave IV., figs. 1-2.

Diagnosis.—Small simple or dendroid *Carcinophyllum*; the central column is dibunophylloid and dense with stereome; the stereozone is wide and only infrequently interrupted by coarse dissepiments. Gemmation is calicular.

Description.—The corals when simple are slenderly conical attaining a maximum diameter of 13 mm. The average diameter is 10 mm. at a height of 40 mm. The dendroid forms arise by calicular budding, three or four hystero-corallites being given off from the parent calyx. The epitheca shows wide arched interseptal ridges, with deep narrow septal grooves. The septa are of two orders, usually about 24 of each, but there may be as many as 30. They are pinnately fibrous and thick, being lined or invested with fibrous stereome. The major septa are usually discontinuous with the lamellae of the central column. The minor septa are short, and the peripheral stereozone is as wide as the length of the minor septa. Its continuity is usually due to the major and minor septa being so thick as to be in contact, but any interseptal loculi may be filled by fibrous stereome resting on horizontal tissue and lining (investing) the already dilated septa. In mature corallites the septa may withdraw from their bases at the epitheca and large dissepiments convex upwards and inwards arise, on which the septa may be represented as stout crests. Since loculi rarely occur between the major and minor septa, fine dissepiments are usually absent. Small thin concave tabulae occur between the central column and the stereozone, widely spaced and seldom invested with stereome.

(1) A neotype for this species is being described.

The central column, whose diameter may be one third that of the corallite, consists of a medial plate with a few sinuous vertical lamellae abutting on to it, and long highly inclined tabellae ; the vertical elements may be so dilated and so much stereome may be deposited on the upper surfaces of the tabellae that the column may be solid. In rare instances it is free from stereome, and in this case it loses its definition, the inner series of tabellae becomes continuous with the outer, and the septa also are less dilated (Plate IV, figs. 14-17).

Distribution.—In addition to the type locality where it is common, this species occurs in Viséan limestones at Old Cannindah Homestead, near Monto, Queensland.

Remarks.—This species is remarkable for its tendency to become dendroid, and for its constant possession of a stereozone. The stereozone, in that it is as wide as the minor septa are long, and in that it may be formed by the dilated septa coming into contact, resembles the stereozone of the Permian corals of Timor, such as '*Carcinophyllum*' *wichmanni* (Rothpletz). The consequent repression of interseptal dissepiments is also characteristic of the Permian corals, but in the latter the peripheral withdrawal of the septa, with the formation of large dissepiments does not occur. Among the English representatives of the genus, *C. patellum* resembles *C. densum* Ryder from the D_2 zone the most closely.

Genus LITHOSTROTION Fleming.

Lithostrotion **Fleming 1828, p. 508.**
Genotype.—Lithostrotion striatum **Fleming 1828, p. 508,** = ***Lithostrotion sive Basaltes minimus striatus et stellatus,*** **Lhwyd, 1699, p. 124 ; Pl. (xvi) ; 1760 Editio altera, p. 125, Pl. xxiii.**[1]

Diagnosis.—'Phaceloid and cerioid Rugose Corals which have, typically, a columella, long major septa, and large tent-shaped tabulae, usually supplemented at the theca by smaller and nearly horizontal tabulae. Dissepiments are well developed in the larger species, but absent in the very small forms. Gemmation is nonparricidal. Diphymorphs of *Lithostrotion* have no columella, short septa, flat or distally arched tabulae, and, in the phaceloid forms, parricidal gemmation.'[1]

Remarks.—The genus is very prolific in the lower Carboniferous of Europe, Asia and Australia. The boundaries of both the genus and its species are extremely difficult to define, since the individuals of all species vary a great deal. The group is more easily dealt with and understood if we postulate that the members of the genus *Lithostrotion* Fleming all possess potentialities to follow definite developmental trends[2] ; *i.e.*, characters potentially common to the group as a whole may be expressed or suppressed in different individuals. The common trends in *Lithostrotion* are :—

1. The progressive development in external form usual in Rugose corals from dendroid forms through phaceloid and cerioid to asteroid forms. In the last stage there is a correlative change in internal structure.
2. The eridophylloid trend ; *i.e.*, a tendency for neighbouring corallites in dendroid and phaceloid forms to become united by lateral outgrowths of extratabulate tissue.

(1) Smith and Lang, 1930, p. 178.
(2) *See* Lang, 1923, pp. 120-136.

3. Trends in structure in the axial region.

(*a*) The diphyphylloid trend; the septa withdraw from the axis, the columella disappears, and the tabulae become flat or distally arched.[1] Diphyphylloid individuals (diphymorphs) have been separated off from the typical *Lithostrotions*, *i.e.*, those with long septa, by Smith and Lang (1930, p. 179) as genomorphs of the genus. A genomorph of *Lithostrotion* is understood to be a group of individuals in which a trend common to all members of the genus reaches an expression whereby the group is well demarcated from typical *Lithostrotion*. Such individuals may arise in any species of the genus. A diphymorph is a genomorph in which the trend concerned is the diphyphylloid trend.

(*b*) A clisioid trend; the more or less complete tabulae of the typical forms become replaced by small, incomplete tabulae or tabellae, which may become arranged in an axial and a periaxial series, the columella being retained. Phaceloid and cerioid groups of individuals in which the tabulae are replaced by tabellae (not arranged in axial and periaxial series) have been separated off by Schindewolf[2] into the subgenera *Cystidendron* Schindewolf and *Cystistrotion* Schindewolf. If the conception genomorph be accepted, then these two might also logically be regarded as genomorphs.

(*c*) A cionoid trend; in which the columella becomes very large. It may be expressed independently of the clisioid trend, or the same individuals might show both. *Cinoodendron* Benson and Smith was erected to receive two specimens which might be regarded as *Lithostrotion* with abnormally large columellae.

4. The lonsdaleoid trend; the septa retreat from the epitheca leaving a coarse peripheral ring of dissepimental tissue, on which they may be represented as crests. A cerioid group showing this trend well developed has been separated off by Yabe and Hayasaka (1915, p. 93) as a sub-genus *Lithostrotionella* Y. and H. This might also be regarded as a genomorph.

(1) In this connection it should be noted that amongst groups related to *Lithostrotion* and at present recognised as distinct genera, the axial structure of *Nemistium* Smith, and the long axial septum of *Dorlodotia* Salee and *Thysanophyllum minus* Nicholson and Thomson possibly represent intermediate halted stages in the development of the diphyphylloid trend, or may be quite independent developments. In many cases it is uncertain whether forms without a columella have been derived from columellate forms or *vice versa*. In *Orionastraea lonsdaleoides* nov., however, the forward trend leading from cerioid to asteroid forms is accompanied by columellate corallites becoming diphyphylloid; the tabulae become flat and complete, and not distally arched or divided into an inner and an outer series. No corallites with a *Nemistium*-like axial structure are seen, but the long axial septum characteristic of *T. minus* is a frequent occurrence. (*Diphystrotion mutabile* nov.) gives no clue as to whether the non-columellate corallites are derived from columellate or *vice versa*, but the same remarks may be made about its axial structures as about those of *O. lonsdaleoides*.

(2) Schindewolf (1928 pp. 148-51) also separated the columellate *Lithostrotions* with complete tabulae and fine interseptal dissepiments into two subgenera; *Siphonodendron* M'Coy (phaceloid) and *Lithostrotion* Fleming (cerioid).

Except where mutually exclusive, all these various trends may be found in one and the same individual; but usually only one is pronounced; and the individuals thus distinguished may be united in genomorphic groups. As far as we know genomorphs may arise at any period within the range of the genus.

It is to be noted that it is convenient to regard as a *genus* the group of forms included in *Orionastraea* Smith, which differs from typical *Lithostrotion* in the manifestation of *two* internal structural trends in an advanced stage—that due to the change from cerioid to asteroid form, and the diphyphylloid trend. *Orionastraea* merges into *Lithostrotion* in the species *O. ensifer*. If the groups *Dorlodotia* Salee and *Thysanophyllum minus* Thoms. and Nich. be derived from *Lithostrotion* Fleming, then here also two trends have been concerned.

Remarks on the Australian species.—Three Australian species of *Lithostrotion* Fleming, *L. columnare*, *L. arundineum*, and *L. stanvellense* have already been described by R. Etheridge Jr. (1900, p. 10), who placed them provisionally in this genus, and their status was confirmed by Dr. Stanley Smith (1920, p. 61). Etheridge's three species are here redescribed on topotypic material and on specimens from other localities in Queensland and New South Wales. Variation in the Australian species seems to be caused by differences in the degree of development of trends which all the individuals possess in common; and in such variation they agree with their European congeners. Also, while in some localities a species is more or less variable, in other places, more rarely, no variation is apparent, and the species may be spoken of as having reached a stable expression; *i.e.*, in some localities a particular expression is only one amongst a whole series, but in one locality it is isolated. It is possible then, that sometimes the expression of a trend may be a function of the geography of the individual.

The Australian species "agree in all essential characters with their European congeners. Yet as a group they present certain distinctive characters." [1]. These differences may be summed up as follows:—

1. 'Columella. This is usually much stouter than in British species.
2. Tabulae. The tabulae in the Australian species are to a great extent replaced by arched tabellae;'[2] 'or are sharply bent, as in *Cionodendron*.'[3]. In the case of *L. columnare* and *L. arundineum* there is moreover a marked tendency for the tabulae to become strongly differentiated into an axial and a periaxial series, the inner series being strongly arched and fairly uniform, and the outer irregularly disposed and on the whole more widely separated, some being nearly flat and horizontal, and others steeply inclined and more curved.
3. 'Septa. The septa exhibit a marked tendency to become disunited from the epitheca in the adult stage.'[3]. Axially the septa are typically grouped, and whether grouped or not, confluent with the columella.

(1) S. Smith, 1920, p. 61.

(2) Because of this replacement Schindewolf (1928, p. 149) placed these species in his subgenera *Cystidendron* and *Cystistrotion*.

(3) Benson and Smith, 1923, p. 169.

4. 'Dissepiments. Dependent upon the disruption of the septa from the epitheca, the external dissepiments (not being intercepted by the septa) frequently form an outer zone entirely built up of course dissepimental tissue as in *Lonsdaleia.*

It is the prevalence and combination of these characters, and not the presence of any one of them, that distinguishes the Australian from the British forms, since in the less typical examples among the British species such features may occasionally be noted.'[1] In other words we may say that the British and Australian species possess in common the same trends ; but certain of these tend to be expressed more strongly in one continent than in the other.

LITHOSTROTION COLUMNARE Etheridge. Plate X, figs. 18–25.

Lithostrotion (?) *columnare* Etheridge fil. 1900, p. 18 ; Pl. i, fig. 1 ; Pl. ii, figs. 1-5.
Lithostrotion columnare Eth. fil., S. Smith, 1920, p. 61 ; Pl. v, figs. 1-2.
Cystistrotion columnare (Eth. fil.) Schindewolf, 1928, p. 149.
Lectotype.—(here chosen), F 1604 in the Queensland Geological Survey collection, from the Upper Viséan Lion Ck. Limestone, Stanwell, near Rockhampton, Queensland, being the original of Etheridge's Pl. ii, fig. 1.

Diagnosis.—Large cerioid *Lithostrotion* comparable in size with the British *L. arachnoideum* (M'Coy) showing great variation ; major septa confluent with strong columnella ; minor septa long and dissepimental tissue copious ; tabulae incomplete, variable.

Description.—The corallum is compound, large, cerioid or occasionally partly asteroid. The corallites are long and straight with an average diameter of 10 mm.[2] The epitheca of each corallite is variably developed, and may be thickened, or thin and irregular, or as a line of vesicles filled with secondary deposit. There are 20 to 25 stout septa of each order ; their peripheral edges are usually in contact with the epitheca (Plate IV, fig. 18), but may sometimes withdraw and be separated from it by dissepiments (Plate X, fig. 23, the lonsdaleoid trend), or they are occasionally irregular in course and confluent with those of contiguous corallites (Plate X. fig. 25, the asteroid trend). The axial edges of the major septa are confluent with the columella, either separately or conjoined in groups. The minor septa attain two-thirds the length of the major. Dissepiments are small, numerous (4 to 7 rings), and regular except at the epitheca where they may be coarsely developed (Plate X, figs. 23–24), the lonsdaleoid trend ; or they may be continuous with those of neighbouring corallites (Plate X, fig. 25), the asteroid trend. The inner ring of dissepiments is sporadically invested with stereome. The columella is styliform or cylindrical in transverse section and usually thickened. The tabulae are incomplete ; they are to a great extent replaced by strongly arched tabellae, convex upwards and outwards and varying in size (Plate X, figs. 19–20) ; or more rarely (and this is a constant character in Riverleigh specimens) they may be strongly differentiated into an axial and a periaxial series, the tabellae of the inner series being strongly arched and fairly uniform, and those of the outer irregularly disposed and on the whole more widely separated, some being nearly flat and horizontal and others steeply inclined and more curved (Plate X, figs. 20 and 22). Gemmation is always intermural.

(1) Benson and Smith, 1923, p. 169.

(2) The Riverleigh individuals (Plate X, figs. 21-22) are much smaller, with a constant diameter of 5 mm.

Distribution.—In addition to the type locality the species occurs at Horton R., between Eulowrie and Pal Lal, New South Wales, in the Viséan Burindi limestones, and in the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland.

Remarks.—Variation is very pronounced in the Lion Ck. and Horton R. specimens; but the Riverleigh corallites have a constant expression, which however is seen in some Lion Ck. specimens. The variation can be said to be due to sporadic weak expressions of the lonsdaleoid and the asteroid trends, and of trends leading to incompleteness of the tabulae and to the arrangement of the replacing tabellae in axial and periaxial series. The only one of these trends expressed in the Riverleigh specimens is the last, and the tabellae are always arranged in axial and periaxial series. This material is also distinguished by the constant small size of its corallites (5 mm. diameter) and correspondingly smaller number of septa. The reason of this stabilization, whether difference of horizon or habitat or some other cause, has not been ascertained.

LITHOSTROTION STANVELLENSE Etheridge (Plate IV, figs. 26–33, text-fig. 3).

Lithostrotion (?) *stanvellensis* (*sic*) Etheridge fil., 1900, p. 20; Pl. i, fig. 5; Pl. ii, figs. 7-8.
Lithostrotion stanvellense Eth. fil., S. Smith, 1920, p. 63; Pl. iii, figs. 1 and 3-6; Pl. iv, figs. 1, 1a, and 3.
Cystidendron stanvellense (Eth. fil.), Schindewolf, 1928, p. 149.
Lectotype.—(here chosen) F 1603 in the Geological Survey of Queensland collection, from the Upper Viséan Lion Ck. limestone of Stanwell, near Rockhampton, Queensland, being the original of Etheridge's Pl. i, fig. 5.

Diagnosis.—Large dendroid *Lithostrotion* comparable in size with the British *L. martini* Edwards and Haime; major septa confluent with a strong columella; minor septa short and dissepimental zone narrow; tabulae typically incomplete. Gemmation lateral. The septa may withdraw from the columella and budding is then calicular.

TEXT-FIGURE 3.
Lithostrotion stanvellense Eth. fil.
Upper Viséan Riverleigh Limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. F. 2945 in the University of Queensland collection. Natural size.

Description.—The corallum is dendroid (text-fig. 3) or inclined to caespitose, and large, and the corallites are then irregular in direction of growth, long, and usually between 8 and 10 mm. in diameter, though diameters of 5 mm. and 15 mm.[1] are not infrequent the epitheca shows well-marked growth accretions and indistinct striae. A phaceloid corallum is also known[2], in which the corallites are close and parallel, and may attain the gigantic diameter of 22 mm. (Plate X, fig. 27), the epitheca being regularly ornamented with both annulations and striations.

The septa are straight, usually unthickened, and vary in number according to the diameter of the corallite from 24 to 44 of each order. Typically the axial edges of the major septa are grouped and the resultant combined groups are confluent with the columella (Plate X., fig. 26) ; often[3] however, the septa fail to make contact with the columella (Plate X, fig. 27) ; and in one corallum[4] they are withdrawn so far as to be little longer than the minor septa; this weakly diphymorphic corallum shows the calicular budding typical of diphymorphs, although the columella is present (Plate X, fig. 31). The minor septa are short and attain little more than one third the length of the major. The dissepimental zone is narrow and consists of two or three rows of small irregular dissepiments, the innermost being sporadically invested with stereome. Sporadically the peripheral ends of the septa may be separated from the epitheca by large dissepiments (the lonsdaleoid trend). The columella is thickened, and may be round, oval, fusiform or radiate in transverse section. The tabulae are usually incomplete (Plate X, fig. 29), being replaced by copious tabellae of various sizes, convex upwards and outwards, sometimes with short horizontal plates between them and the dissepiments ; but these latter are seldom so numerous as to form a periaxial series. Gemmation is typically lateral[5], but in the weakly diphymorphic corallum mentioned above it is calicular, and the relation between the neo—and atavo—tissues is the same as described by Smith and Ryder (1927, p. 339) in *Stauria favosa* (Linnaeus).

Distribution.—In addition to the type locality the species occurs in the Viséan Burindi limestones of the Parish of Hall, at Hall Ck., near Bingara, New South Wales ; in the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland ; in the Viséan crystalline limestone of Crinoid Mt., Diglum, Barmundoo Goldfield, near Gladstone, Queensland ; and it has been reported (Whitehouse, 1927, p. 189) from Old Cannindah Homestead, near Monto, Queensland.

Remarks.—The Stanwell specimens are typical, with a constant expression, and are notable for the incompleteness of the tabulae and the strength of the columella. The Bingarra and Riverleigh material is however very variable. The Bingara corallites vary in size (Plate X, fig. 32) from 5 to 11 mm., the tabulae are usually complete, the lonsdaleoid trend is weakly expressed and there is much investment by stereome of septa, columella and inner ring of dissepiments. In the

(1) Large forms are common in the Riverleigh limestone.
(2) From the Riverleigh limestone.
(3) Especially in the Riverleigh limestone.
(4) Also from the Riverleigh limestone.
(5) One case was observed in which the bud and parent had a common epitheca, but the corallites were malformed at the contact (Plate X, fig. 28).

Riverleigh limestone the species is very common and the coralla and corallites are usually very large. One large phaceloid colony and one weakly diphymorphic corallum with calicular budding have been collected here. The locality is notable for the weak development of the diphyphylloid trend, shown by the septa failing to make contact with the columella; the tabulae may be complete or incomplete, and the lonsdaleoid trend is weakly expressed. The Barmundoo material is referred to *L. stanvellense* by growth form only, since it is too crystalline to section.

LITHOSTROTION ARUNDINEUM Etheridge (Plate X, figs. 34–38).

Lithostrotion (?) *arundineum* Etheridge fil. 1900, p. 19; Pl. i, figs. 3-4; Pl. ii, fig. 6.
Lithostrotion arundineum Eth. fil., S. Smith, 1920, p. 63; Pl. iv., figs, 2, 2a).
Cystidendron arundineum (Eth. fil.) Schindewolf, 1928, p. 149.
Lectotype.—(here chosen) F 1602 in the Geological Survey of Queensland collection from the Upper Viséan Lion Ck. limestone of Stanwell, near Rockhampton, Queensland, being the original of Etheridge's Pl. i, fig. 3.

Diagnosis.—Phaceloid *Lithostrotion* comparable in size with the British *L. irregulare* auctt.; the major septa are typically confluent with the strong columella; the dissepimental zone is very narrow; the tabulae are incomplete, and the tabellae are typically arranged in an axial and a periaxial series. Gemmation is lateral.

Description.—The corallum is phaceloid and large; the corallites are long, straight, parallel, close, often in contact, 4–5 mm. in diameter; they are thinly epithecate, with delicate growthrings and distinct interseptal ridges. There are about 20 septa of each order, straight and sometimes dilated. Typically the axial edges of the major septa are confluent with the columella (Plate X, fig. 34), either previously conjoined in groups or independently; but they often fail to make contact with the columella, abutting instead on the axial tabellae[1]. The minor septa are short, less than half the length of the major. Dissepiments are correspondingly few and are small and regular, the inner ring being frequently invested with stereome. The strong columella is cylindrical or styliform in transverse section, often much thickened. The tabulae are incomplete[2] and the replacing tabellae are usually arranged in an axial series of strongly arched and fairly uniform plates, and a periaxial series of irregularly disposed and rather more widely separated plates, some being nearly flat and horizontal, and others more steeply inclined (Plate X, fig. 35). Gemmation is always lateral.

Distribution.—In addition to the type locality, the species is known from Viséan limestones at :—

1. Near the police station, Horton R., County Murchison, New South Wales.
2. Between Eulowrie and Pal Lal, Horton R., Co. Murchison, N.S.W.
3. Crinoid Mt., Diglum, Barmundoo Goldfield, near Gladstone, Q.
4. Mt. Grim, Gladstone District, Q.
5. Near Texas, South Queensland.

Remarks.—The Stanwell specimens are stable save for a frequent slight expression of the diphyphylloid trend. This is also seen occas-

(1) At Stanwell and the Horton R.
(2) Except at Mt. Grim.

ionally in the Horton R. material which however is also notable for the stereoplasmid thickening of the vertical elements, particularly the columella (Plate X, figs. 36–38), which attains a size comparable with that of *Cionodendron columen* Benson and Smith[1] (Plate X, figs. 39–40). Probably some of these Horton R. specimens, *e.g.*, figs. 37–38 should be regarded as *C. columen.* Work on this point is in progress. The Barmundoo specimens are referred to *L. arundineum* on external form only, since they are too crystalline to section. The Mt. Grim specimen also is rather crystalline. In the few corallites in which the structure is clear, all the septa reach the columella, and the tabulae are complete. All that can be said of the sheared Texas specimen is that it belongs to *Lithostrotion* more probably than to any other genus. It resembles *L. arundineum* in size and form, and appears to have a columella. If it be *Lithostrotion* then the 'Gympie Series' of the Texas District includes Lower Carboniferous beds.

LITHOSTROTION, genomorph (*Diphyphyllum* Lonsdale).

Lithostrotion Fleming 1828, p. 508, genomorph (*Diphyphyllum* Lonsdale) Smith and Lang 1930, p. 180.

Genomorphotype.—Diphyphyllum concinnum Lonsdale 1845, p. 624; Pl. A, fig. 4. (Since the type of *D. concinnum* is lost, Smith and Lang, 1930, p. 180, base their description of *Diphyphyllum* on *D. lateseptatum* M'Coy, 1849, which 'if not conspecific is certainly congeneric with *D. concinnum*').

Diagnosis.—'Phaceloid *Lithostrotion* which have no columella, or one which is reduced to spines on successive tabulae. The axial tabulae may be flat or convex, but have downturned edges which either meet the tabulae below them or extend to the dissepimental wall; the outer, smaller tabulae abut against the inner tabulae. The dissepiments, which are small, are well developed in the larger forms. Gemmation is parricidal.'[2]

Remarks.—The genomorph[3] occurs in abundance in the Viséan limestones of Europe, usually in association with *Lithostrotion.* It is possible that it contains representatives of a primitive stage of *Lithostrotion,* and also forms derived from *Lithostrotion* by reversion.[1]

LITHOSTROTION sp. (*Diphyphyllum* sp.). Plate XI, figs. 1–2.

Diphyphyllum sp. Benson and Smith 1923, p. 168.

Material.—No. 4510 or 4515 in the collection of the Geological Survey of New South Wales, and sections R 20872 and R 21998 in the British Museum and A 5494 in the Sedgwick Museum; from the Viséan Burindi limestone of the Parish of Moorawarra, near Somerton, New South Wales.

Description.—The material consists of a large number of broken and isolated corallies. Each is about 5 mm. in diameter, and straight. There are from 12 to 20 septa of each order. The major septa extend about half-way towards the axis, and the minor septa are half this length. The dissepiments are confined to one or two rings, and are small and regular. The tabulae are of two series, the inner ones being large and almost horizontal, and the outer small and sloping downwards to the dissepiments.

(1) Were it not for the greater number of septa and the sharply bent tabulae, *C. columen* might be regarded as *L. arundineum* in which the columella is even more strongly developed than in the Horton R. specimens.

(2) Smith and Lang, 1930, p. 180.

(3) Smith and Lang (loc. cit.) 'restrict the genomorphic name (*Diphyphyllum*) to the diphymorphs of *Lithostrotion,* considering that in this group the diphymorph structure is a condition due to other causes than normal phyletic development; and that a suitable stimulus may start any individual along this trend.'

Remarks.—This is the only example of (*Diphyphyllum*) known from Australia. The diameter of its corallites and the number of septa suggest relation to *L. arundineum* Etheridge. It would not be surprising however if further material showed that these specimens should be placed under *Aulina simplex* sp. nov. The diphymorph condition is extremely rare in Australian *Lithostrotions* ; even the slight withdrawal of the septa from the columella is infrequent, whereas it is usual in almost all British *Lithostrotions*, with the notable exception of the Scottish forms described by Thomson (1883, pp. 397-406) which compare with the Australian forms.

LITHOSTROTION genomorph (*Diphystrotion* Smith and Lang).

Lithostrotion Fleming 1828, p. 508, genomorph (*Diphystrotion* Smith and Lang) 1930, p. 184.

Genomorphotype.—*Stylastraea inconferta*, Lonsdale, 1845, p. 621, Pl. A, figs. 2, 2a-c. Smith and Lang 1930, p. 184.

Diagnosis.—' Cerioid *Lithostrotion* in which there is no columella, or one which is reduced to spines on successive tabulae, and in which the tabulae are slightly convex or flat and in most cases complete. The dissepimental tissue is typically coarse. Parricidal gemmation has not been observed.' [1]

Remarks.—The cerioid diphymorph is less common than the phaceloid, and the individual corallites always show great variation.

LITHOSTROTION sp. (*Diphystrotion mutabile* sp. nov.). (Plate V, figs. 3–4)

Holotype.—F 2387 and 4 slides cut from it, in the University of Queensland collection from the Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, Queensland. Part of the Holotype is a 5492 in the Sedgwick Museum, Cambridge. Plate V, figs. 3-4.

Diagnosis.—(*Diphystrotion*) with much thickened corallite walls, and with dissepiments sparsely and sporadically developed.

Description.—The corallum is cerioid. The corallites are of sinuous growth, with an average diameter of 4 mm. (Plate V, figs. 3–4. The epitheca of each always has a lining of stereome about 0.55 mm. thick. The internal structure varies sporadically in each corallite, and from corallite to corallite. The septa are stout, rather sinuous, and sometimes separated from the epitheca by dissepiments on which they may leave crests. There are from 12 to 16 of each order. The major septa are of variable length ; the axial edges of 3 to 5 (two being opposite), may very occasionally meet in the eentre to form a columella ; or the major septa may be only half as long as the radius of the corallite. Intermediate stages between these extremes are more often seen, a frequent feature being the greater length of one, or of two opposite septa. The minor septa are very short with an average length of one third the radius of the corallite. Dissepiments occur sporadically, usually as a single ring of rather large plates between the septa. They may be entirely lacking, and sometimes some of the septa withdraw from the periphery, when a coarse dissepimental tissue develops as in *Lonsdaleia*. The tabulae are usually complete and almost horizontal ; but they may be broken or bent up by long axial edges of septa, or by an occasional columella ; where no dissepiments are present the tabulae extend to the epitheca. They are closely spaced, 10 being counted in a space of 5 mm. The columella when

(1) Smith and Lang, 1930, p. 184.

present is discontinuous, or is represented by crests of axial septal edges on the tabulae.

Remarks.—The type specimen is the only one known. It is probably not the diphymorph of *L. columnare* Eth., the only cerioid *Lithostrotion* found with it. Variation is extreme, sporadic, and not at all progressive with growth, this applying even to the development of dissepiments. The diphyphylloid trend is almost completely expressed; and the lonsdaleoid trend is expressed weakly and sporadically.

Genus CIONODENDRON Benson and Smith.

Cionodendron Benson and Smith 1923, p. 165.

Genotype.—*Cionodendron columen* Benson and Smith 1923, p. 165-7, Pl. viii., figs 4-5; Pl. ix, figs. 4 and 7, from the Viséan (Burindi) of New South Wales.

Diagnosis.—Phaceloid Rugose corals identical in general structure with *Lithostrotion* Fleming, and comparable in size with *L. arundineum* Eth., but distinguished by the excessively large and well formed columella, the dilated septa, and the sharply bent tabulae.

Remarks.—*See* below.

Cionodendron columen Benson and Smith. Plate IV, figs. 39–40.

Cionodendron columen Benson and Smith, 1923, pp. 165-7; Pl. viii, figs. 4-5; Pl. ix, figs. 4 and 7.

Holotype.—No. 1464 in the Geological Survey of New South Wales collection, from the Viséan Burindi series of Slaughterhouse Ck., near Gravesend, N.S.W. Sections from it have been placed in the British Museum, R 21999 and R 22000-01. Plate IV, figs. 39-40. Also figured Benson and Smith 1923 Pl. viii, figs. 4-5; Pl. ix, figs. 4 and 7.

Diagnosis.—As for genus.

Description.—That given by Benson and Smith (1923, pp. 165-7) is adequate and easy of reference.

Remarks.—In growth habit and size of corallites the species closely resembles *L. arundineum* Eth., but is distinguished by the abnormally strong columella, the constancy with which the major septa are confluent with it, the greater number of septa (26 of each order as against 20), and the nature of the tabulae which " for the greater part extend from the theca to the columella, but are bent irregularly and at high angles both towards the theca and the columella." [1] Many corallites called here *L. arundineum* from the Horton R., N.S.W, show columellate-septate characters near those of *C. columen*, but have tabellae arranged on the *L. arundineum* plan. (Plate IV, figs. 37–38). Further work on these forms is in progress, and it is hoped will clarify the relation between the two species.

In addition to the specimen from the type locality Benson and Smith described (1923, p. 167) an isolated corallite associated with (*Diphyphyllum*)[1] in the Parish of Moorawarra near Somerton, N.S.W.

Genus ORIONASTRAEA Smith.

Orionastraea Smith 1916a, p. 2; 1917, p. 294.

Genotype.—*Sarcinula phillipsi* M'Coy 1849, p. 125; Smith 1917, p. 298, Pl. xxiii, figs. 1-2.

Diagnosis.—Asteroid or sometimes partly cerioid Rugose corals, related to *Lithostrotion*, but with columella weakly developed or absent; with septa withdrawn from the axis, and sometimes also from the periphery.

(1) *See* p. 54.

Remarks.—The genus is demarcated from the *Lithostrotion* group in that the development of the diphyphylloid condition is constantly accompanied by the loss of the dividing epitheca and sometimes also by the development of a lonsdaleoid condition. As above defined the genus has probably arisen from different species of *Lithostrotion* and (*Diphystrotion*). In England it is characteristic of the uppermost Viséan. The one Australian species appears to have been derived from the massive *L. columnare* Eth. by the three changes mentioned above, since the two are found at the same locality and horizon, and these three conditions are seen weakly and sporadically developed in *L. columnare.*

ORIONASTRAEA LONSDALEOIDES sp. nov. (Plate V., figs. 5–11).

Holotype.— F 2938 and slides in the University of Queensland collection from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Part of the holotype has been placed in the Sedgwick Museum, No. A 5485, Plate V, figs. 6-8.

Diagnosis.—*Orionastraea* with the numerous septa of neighbouring corallites separated by a wide development of coarse peripheral dissepiments, with rare traces of epitheca ; a degenerate columella is often present.

Description.—External characters : The corallum is asteroid, spreading and large. The few calices observed show a central cone rising from a deep narrow collar-like trough ribbed with septa, the trough having a wide broadly domed rim formed by the broadly arched dissepimental tissue between the septa of two neighbouring corallites. The holotheca[1] is thick, with well marked growth rings and longitudinal striations.

Internal structures :—The corallites have an average diameter of 10 mm. The septa of each are withdrawn from the periphery and confined to a periaxial column about 5 mm. in diameter. They are rather sinuous and thin, and there are from 16 to 18 of each order. The major septa are of unequal lengths ; they may all be withdrawn from the axis ; but usually one (or sometimes two) is longer than the others, and has a thickened axial edge ; often the axial edges of a few others unite with this thickened one, and a degenerate type of columella is thus formed. The minor septa are also of unequal length, about half as long as the major. Since the septa are withdrawn from the periphery. each corallite has a peripheral zone of dissepiments about 2.5 mm. wide, in which the original course of the septa may occasionally be traced by crests. These dissepiments are very coarse and broadly arched, and usually continuous with those of neighbouring corallites since only rare traces of a dividing epitheca in the form of palisade-like rods, occur. The dissepiments are arranged domewise over the position of the lost epitheca, and incline so steeply downwards towards the tabulae that they form an almost continuous wall to the septal columns. Small dissepiments are sometimes developed between the major and minor septa. The tabulae are confined to the septal columns. They are closely packed and usually complete and horizontal, but may be broken and bent up by the axial edges of longer major septa, or by a degenerate columella.

(1) Hudson 1929, footnote p. 442, ' the outer covering of the cerioid corallum and the basal epitheca of the astraeoid corallum.'

Ontogeny:—Buds may arise calicularly (as in phaceloid diphymorphs) but are parricidal only when they are axial in origin. Non-parricidal buds may also arise, more rarely, from the dissepiments above the position of the lost epitheca; this type of budding is probably a relic of the mural budding characteristic of columellate *Lithostrotions.* The initial stage in budding is the formation of a concavity in a small area of the floor tissue, and in this the new structures are laid down, rather thicker than the old. Vertical septal ridges, irregular in course, grow in no set order, and there is very little difference between major and minor septa. Occasionally one seems longer than the others, or possibly two opposite ones join, but there is nothing definitely to prove the presence in the embryo of a columella. But the buds are hysterocorallites, and as such would not be expected to recapitulate in ontogeny the phylogeny of the species. The septa next approach radial regularity, one being longer than the rest, and major and minor septa are distinct and alternate, but without dissepiments between them. Meanwhile the external dissepimental tissue is growing up as a coarse encircling tissue. The normal adult expression is attained by the development between the outer parts of the septa of small dissepiments, and a senile stage is reached by the breaking away of these into the peripheral tissue, carrying on them the septal crests.

Remarks.—This species, which is known only from the type locality, is undoubtedly a transitional one; for the loss of the epitheca is not entire, and the corallum is not so spreading nor the dissepimental tissue so flat as in typical species of *Orionastraea*; while the imperfect development of the diphyphylloid condition is seen in the presence of a degenerate columella, and in the occurrence of both parricidal and non-paricidal gemmation. The lonsdaleoid condition is the only one fully developed. In its presumed derivation from *L. columnare* Eth., this species is an interesting example of parallel evolution in different species of the same form group in places as far apart as Queensland and England.

Genus AULINA Smith.

Aulina Smith 1916a, p. 2; 1917, p. 290.
Genotype.—*Aulina rotiformis* Smith 1916a, p.p. 2-3; 1917, pp. 290-4; Pl. xxii, figs. 6-11, and text-figs. 3-4.

Diagnosis[1].—Simple, phaceloid or asteroid Rugose corals in which an inner tube or aulos is formed by the union of the deflectal axial edges of the major septa. The aulos separates the inner larger tabulae, which are flat, from the more numerous outer and smaller tabulae, which slope outwards and downwards. If a dissepimental wall be present all the septa are dilated at it.

Remarks.—*Aulina*, which occurs in the Upper Viséan limestone of the north of England, has been regarded (Smith 1925, p. 495 and 1928, p. 119) as representing an endpoint of a lineage from *Lithostrotion* Fleming. The occurrence in Australia of a simple *Aulina*, however, makes it more probable that the English compound species have developed from some undescribed simple aulate form than from (*Diphyphyllum* β Smith).

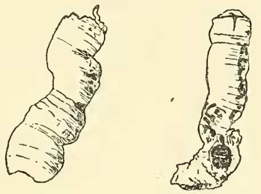
(1) Amended from S Smith 1925 p. 486, and 1928 p. 114.

AULINA SIMPLEX sp. nov. (Plate V., figs. 12–29, text-fig. 4).

Holotype.—8 slides (F 2939) in the University of Queensland collected from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Plate V, figs. 13-29.

Diagnosis.—Simple *Aulina* with very sparse dissepiments.

Description.—The corallites are simple, elongately conicocylindrical (text-fig. 4), and of irregular appearance due to short irregularities in the direction of growth, and to growth constrictions and swellings. The average diameter attained is about 5 mm. The epitheca is thick, with indistinct striae. Root processes are often present.



TEXT-FIGURE 4.
Aulina simplex sp. nov.
Paratype F 2940 in the University of Queensland collection. Natural size.

There are about 20 thin septa of each order, the minor septa being extremely short and tooth like. The major septa are deflected axially and unite to form the aulos or septal tube, the deflection beginning about half way between the epitheca and the tube. The aulos thus firmed is wide, about one third the diameter of the corallite. It shows considerable variation. It may be perfectly curved ; rarely it may be incomplete and horse-shoe shaped, while in some sections (Plate V, fig. 14) it is absent, and the short amplexoid septa are straight. In this latter case the tabulae are complete and horizontal (Plate V, fig. 12), of one series only. Usually the tabulae are well differentiated into an inner and an outer series separated by the aulos. Those of the inner series are horizontal, about 4 in a space of 3 mm. Those of the outer series are thinner, and almost twice as numerous (Plate V, fig. 16), and incline steeply downwards to the epitheca, or dissepiments if these are present. Dissepiments are but seldom developed, never well enough to form a complete ring. They may separate the septa from the epitheca (Plate V, fig. 14).

Ontogeny: Only two specimens were suitable for ontogenetic study. The earliest stage of each examined (diameter 1 mm.) showed at strong epitheca with straight septa meeting at the axis (Plate V, fig. 29). In one (corallite A), the arrangement was pinnate ; but in the other, the holotype (F ghi) it was approximately radial. Only the holotype showed the formation of the aulos (Plate V, fig. 13-29), which appeared at 1.5 mm. diameter as an open loop ; the axial ends of two septa diverged, and met their similarly directed neighbouring septa so that an open loop resulted. A root process then caused disturbance in the arrangement, and at a diameter of 2 mm. the aulos was seen to be complete. In corallite A, however, it was already complete at 1.5 mm. diameter and it cannot be argued on the above evidence that the aulos is first formed as an open loop, since in the holotype the presence of the root process may have been responsible for such an origin. The adult stage is attained by the cyclic insertion of very short minor septa, and the sporadic appearance of dissepiments.

Remarks.—The aulos is rather less perfectly developed than in the English phaceloid and asteroid species.

Variation in Rugose Coral Species.

The description given above of the Lower Carboniferous Corals of Australia may be said to demonstrate the great variation possible in Rugose coral species.

That species are variable in a manner quite distinct from and additional to ontogenetic changes, is more easily proved in compound than in simple species, for differences between individual corallites in a corallum are self-evident and striking. So much so that an investigator working with the inelastic idea of the fixity of characters of a coral species would have no hesitation in placing two such different corallites, which might have been found broken from the corallum, into two different species or even genera. Recent papers by English authors (particularly Dr. Stanley Smith), on species of *Lonsdaleia* M'Coy (Smith 1916) and *Corwena* Smith and Ryder (1926) in the Carboniferous, and of *Stauria* Edwards and Haime (Smith and Ryder, 1927), *Xylodes* Lang and Smith and *Kodonophyllum* Wedekind, (Smith and Tremberth, 1929), and *Acervularia* Schweigger (Smith and Lang, 1931) give excellent demonstrations of the variation possible among individuals in a corallum.

That variation is equally great in simple species is not so evident, but failure to recognise it has clouded the study of corals with endless lists of synonymous species. In Great Britain the chief unfortunate effect has been the host of species erected by the pioneer James Thomson[1] for the Scottish Lower Carboniferous corals. That the principle of the fixity of minute characters in a coral species as used by him is wrong is proved by the fact that later workers have never been able to apply his nomenclature, for no specimens could be found to fit in with all the numerous fixed specific characters required. Thomson was particularly unfortunate in that he based his genera and species on the nature of the axial structure, for later work (chiefly by Dr. Stanley Smith) has shown that this is the most variable part of the corallum. The chief published papers illustrative of the variation possible within a simple species are perhaps those on *Aulophyllum fungites* (Fleming), (Smith, 1913), *Hettonia fallax* Hudson and Anderson (1928), and *Caninophyllum archaici* (Ed. and Haime) (Lewis 1929). Some species are more variable than others.

Wide variation being recognised as possible in Rugose coral species, the laws governing it should be sought for. A hypothesis of variation which fits in with all facts known to me is put forward in the following paragraphs.

It was seen in the description of *Amygdalophyllum conicum* Hill that one of the chief differences between individuals was in the frequency of the occurrence of septa which had withdrawn from the periphery of the coral so that they were separated from the epitheca or their bases at the epitheca by large dissepiments convex towards the axis. While there was a tendency for the number of such septa to increase towards the calyx, the incidence of the condition could not be said to be due to age alone ; a few septa, chiefly minor, would be

(1) For list of Thomson's papers *see* Gregory 1917.

affected in an early part of the corallite, while higher up they would again be extending normally to the periphery, and others would have withdrawn. It might with justice be said that the condition arises sporadically and is ephemeral. Now when a number of neighbouring septa are affected, and withdrawn a long way from the periphery, a condition like that in *Lonsdaleia* is attained ; and if all the septa are affected, a zone of dissepiments indistinguishable from that in *Lonsdaleia* results. This last is never fully realised in any *A. conicum* known to me. The tendency for the septa to withdraw from the periphery is known as the lonsdaleoid trend[1] ; and we might say that in *A. conicum* the lonsdaleoid trend is weakly, sporadically, and ephemerally expressec ; and it is this which is responsible for part of the variation in *A. conicum*. It is likewise responsible for part of the variation in *Symplectophyllum mutatum* Hill, *Amygdalophyllum inopinatum* (Etheridge), *Carcinophyllum patellum* Hill, the three Australian species of *Lithostrotion* Fleming (*Diphystrotion mutabile* Hill) and *Aulina simplex* Hill.

In the species *Aphrophyllum foliaceum* Hill and *Orionastraea lonsdaleoides* Hill, while there are parts of the corallites where some or all of the septa extend to the periphery, the general condition is one in which the septa are entirely withdrawn from the epitheca and lonsdaleoid border of dissepiments is present which is diagnostic of the species.

Thus the Australian Lower Carboniferous Corals show that the lonsdaleoid trend varies in the degree to which it finds expression ; further, that if the trend is well expressed it tends to be constantly so, and thus to be a diagnostic character ; but if it is ill expressed it tends to operate only sporadically and ephemerally, and thus to be a cause of variation in the species. But the same process has been at work in both cases.

A study of British species leads to the same conclusions. From published descriptions and figures it can be seen that the expression of the lonsdaleoid trend is strong and almost constant and consequently diagnostic in the Silurian *Spongophylloides grayi* (Edwards and Haime) and *Arachnophyllum* M'Coy, and in the Lower Carboniferous *Caninia cylindrica* Scouler, *Lithostrotionella* Yabe and Hayasaka (a Japanese group), *Thysanophyllum minus* Mich. and Thoms., *Dorlodotia* Salee, *Lonsdaleia* itself, and many others. It is weakly, sporadically, and ephemerally expressed, and of variational significance only in *Lithostrotion*, most clisiophyllids, *Caninia* auctt., *Rylstonia benecompacta* Hudson and Platt, *Hettonia fallax*, and many others. It is impossible that all the forms in which it is observed, whether weakly or strongly expressed, can be closely related. In fact it is known in so many Rugose corals that one suspects that it is potential in all Rugosa.

A second variation in *A. conicum* was the occasional slight ephemeral withdrawal of the septa from the axis, with or without a noticeable weakening of the columella. This was seen also in *A. inopinatum* and the three species of *Lithostrotion*. Again, in *Symplectophyllum* and *Aphrophyllum* Smith, neither of which have a columella,

(1) The word trend has come to mean a number of different things to as many different people. I use it in the sense of the original definition of Lang (1923, p. 125) a trend of development is a line along which "a character appears to carry out in its evolution a predetermined course." A phenomenon such as the appearance in many different lineages, by many different paths, of a columella in the Carboniferous should not be referred to as a trend. It is an acme of homeomorphy.

the septa occasionally withdraw from the axis, there is a perceptible weakening in the strength of any axial structure which may have been present, and a flattening of the tabulae. In the two species *Diphystrotion mutabile* and *Orionastraea lonsdaleoides*, however, it is usual for the septa to have withdrawn from the axis, for the columella to be but weakly developed or absent, and for the tabulae to be flattened, although an axial arrangement like that of typical *Lithostrotion* may occur. There can be no doubt that the same trend is responsible in all these cases, but that it varies in the degree of expression.

It can attain an even stronger expression in the English *Lithostrotion* group. Here Smith and Lang (1930) observed that in a number of individuals belonging to any species, irrespective of horizon, the diphyphylloid condition could arise well expressed in only a few, most, or all of the individuals of a corallum. For such a group of colonies which is still within the genus, yet differs in a certain character from typical members of the genus, they propose the term genomorph. They recognise species within a genomorphic group, each species of the genomorph (*Diphyphyllum*) for instance being the diphymorph of its parent species of *Lithostrotion*. While the value of the conception genomorph in systematics is problematical, it is of great use in emphasizing the potentiality of all individuals of a genus to develop in a certain direction.

The trend is also perfectly expressed and diagnostic in the European Silurian *Acervularia brevisepta* Weissermel. It is seen causing variation in species by being but weakly and ephermerally expressed in *Xylodes*, *Kodonophyllum*, *Streptelasma* Hall, *Phaulactis* Ryder, *Koninckophyllum* Thomson and many others.

Thus a survey of the expression of this diphyphylloid trend leads to the same conclusions as that of the lonsdaloid trend.

It has already been seen (pp. 76–78) that the *Naos* trend in septal structure can be a cause of variation in species when it is weakly and ephemerally expressed, or diagnostic in significance when well and constantly expressed.

None of these three trends can be said to be confined to related genera, or to one horizon or one locality ; but all of them may, so far as one's knowledge goes, be expressed in varying degree in any species anywhere at any time.

Up to the present the phyletic aspect of trends of development have received the emphasis in coral literature. But by studying their weaker and more ephemeral expressions we may come nearer to an understanding of variation. One trend of great phyletic significance is the progressive change from simple corals through dendroid, phaceloid, and cerioid forms to asteroid. It cannot be denied that development along this line is potential to all corals. There is no reason to suppose that trends in internal structure also are not potential to all Rugose corals.

I consider it reasonable to state as a working hypothesis that in Rugose coral species variation is the resultant of the differential weak and ephemeral expression of trends which are potential to all. Further these trends may be expressed in any species anywhere at any horizon. By no means all of these trends have yet been defined.

We have no knowledge of the internal and external conditions governing the expression of these trends, except the following observations. Trends which are mutually exclusive cannot find expression in the one individual at the same time. A trend dependent on a certain condition in a coral, such as the *Naos* trend on the dilation of the septa cannot be expressed unless that condition attains. Since some species are variable in most localities, but have a stable expression in others (*e.g.*, *L. columnare* Etheridge), and since also certain trends appear characteristic of a genus in certain districts (*e.g.*, the diphyphylloid trend is well expressed in British *Lithostrotion* and very weakly in Australian *Lithostrotion*), one factor at least is dependent on the geography.

Further work on variation in coral species, on trends of development (particularly in septal structure), and on the conditions governing their expression, is in progress. The corals of the Wenlock limestone of Wenlock Edge form a particular study.

Genus MICHELINIA de Koninck.

Michelinia de Koninck 1842, p. 29.

Genotype.—(genolectotype, *see* Edwards and Haime 1850, p. lx) *Calamopora tenuisepta* Phillips 1836, p. 201, Pl. ii, fig. 30, from the Lower Carboniferous of Bolland and the Mendips.

Diagnosis.—Compound Tabulate corals, with a thick holotheca wrinkled in horizontal swathes ; the corallites grow in bundles and each has a thin epitheca thickly lined with stereome ; septal spines numerous, sometimes very short and irregular ; mural pores very large and remote, and tabulae well developed, complete or incomplete.

Remarks.—Specific differences in this group are chiefly those of external form. In internal structure evolution seems to have been particularly slow, and those of the late Devonian forms are very little different from those of the late Permian forms. Related groups are the dendroid *Rhizopora* de Koninck, the phaceloid '*Beaumontia*' *laxa* (M'Coy), and *Emmonsia parasitica* (Phillips).

MICHELINIA DENDROIDES sp. nov. (Plate V, figs. 30–35 ; text-fig. 5).

Holotype.—F 2941 in the University of Queensland collection from the Upper Viséan Riverleigh limestone of Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. A plaster cast of the holotype has been placed in the Sedgwick Museum, No. A 5491.

TEXT-FIGURE 5.
Michelinia dendroides sp. nov.
Holotype F2949 in the University of Queensland collection. Natural size.

Diagnosis.—*Michelinia* with thin corallites bundled together to form a slender cylinder which is irregular in course, and occasionall ; gives off stunted branches of the same diameter, which carry calicesy the septal spines are very short and ragged, and pores are very scarce.

Description.—The corallum[1] is elongate cylindrical with a diameter of about 10 mm., and is inconstant in the direction of growth. It gives off in different directions at distances of about 10 mm., stunted branches whose length and diameter are approximately the same as the diameter of the parent stem. The calices open at right angles to the surface ; they are circular and deep, and their floors show neither septal striae nor spines. They occur only sporadically on the parent stem, but are grouped together in numbers on the distal parts of the stunted branches. The stereome lining the walls between the calices which open on these branches is very thick ; and on weathered surfaces it appears pitted (Plate V, fig. 30) ; each calice is immediately surrounded by a raised rim, and between two of these rims the stereome is shallowly troughed. The holotheca covering the parent stem and the proximal parts of the stunted branches is coarse, and shows, corresponding to the corallites it covers, series of scallop-like wrinkles, continuous laterally with neighbouring series (text-fig. 5).

The corallites are polygonal in section and have a diameter of 1.5 to 2 mm. ; they may attain a length of 8 mm., and are pipe-like and not trumpet shaped as in *Pachypora* Lindstrom ; they grow parallel with the parent stem and then turn outwards to open approximately at right angles to the surface of the corallum. The buds, which arise intermurally, attain adult diameter very rapidly. The corallite walls have a thick lining of stereome, which increases in thickness towards the calice. The stereome is not channelled as in *Palaeacis* Haime, nor does it show the lamellae and concentric structure of *Pachypora*. Mural pores are very scarce. Septa are developed as short spines ; they are irregular and not easily made out, usually merely giving the wall a ragged appearance. Both complete and incomplete tabulae occur, widely spaced, about 0.5 mm. apart, and usually domed.

Remarks.—The species is interesting by reason of its scolecoid corallum. There is considerable variation in length, the holotype being the longest found. The scarcity of mural pores is worthy of note.

MICHELINIA sp. (Plate V, fig. 36).

Michelinia sp. Etheridge fil. 1900, p. 7.

Material.—The corallum described by Etheridge is F 1597 in the Geological Survey of Queensland collection from the Upper Viséan Lion Ck. limestone at Stanwell, near Rockhampton, Queensland. A further corallum (Plate V, fig. 36) from the same horizon and locality is in the University of Queensland collection.

Description.—The corallum is depressed hemispherical of somewhat irregular growth ; one specimen was 25 by 38 mm., the other about 50 by 40 mm. The corallites are prismatic and crowded and vary in diameter between 2 and 4 mm. The walls have only a thin investment of stereome. Mural pores are very scarce. The septa are developed as vertical rows of tubercles or short spines, apparently not regularly developed. Tabulae are very numerous, usually as anastomosing tabellae ; a few are complete.

Remarks.—This material is insufficient for specific determination. It differs from *M. dendroides* in its massive corallum, its thin walls, and the scarcity of complete tabulae. It possibly belongs to the *M. tenuisepta* (Phillips) group.

(1) The holotype is the only specimen showing the shape.

Genus SYRINGOPORA Goldfuss.

Syringopora Goldfuss 1826, p.p. 75-76.

Genotype.—(Genolectotype, *see* Edwards and Haime 1850 p. lxii) *Syringopora ramulosa* Goldfuss 1826, p. 76, Pl. xxv, fig. 7, from the Carboniferous of Olne in Limburg, Germany. " Edwards and Haime give *Syringopora* as a synonym of *Harmodites* Fischer 1828 (which however was published two years later) and take *S. ramulosa* as the genotype of *Harmodites*, thereby implying that they consider it the genotype of Syringopora."[1]

Diagnosis.—Fasciculate tabulate corals with long thin parallel to remotely diverging tubular corallites, connected by small approximately horizontal tubules containing extensions of the tabulae. Septa may occur as small spinules. The tabulae are infundibuliform and centrally connected to form a siphon which may be crossed by horizontal plates. Gemmation lateral.

Remarks.—I have been unable to examine the type species, but the above diagnosis has been drawn up from characters observed in Goldfuss' figure, Pl. xxv, fig. 7.

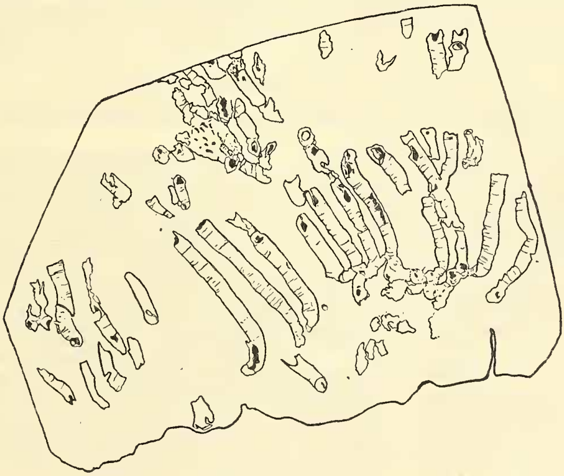
SYRINGOPORA SYRINX Etheridge (Plate XI, figs. 37–39, text-fig. 6).

Syringopora syrinx Etheridge fil. 1900 p. 6, Pl. i, figs. 6-9 ; Pl. ii, fig. 11.

Lectotype.—(here chosen) F 1595 in the Geological Survey of Queensland collection, being the original of Etheridge's Pl. i, figs. 6-9, from the Upper Viséan Lion Ck. limestone at Stanwell, near Rockhampton, Queensland.

Diagnosis.—*Syringopora* with sub-parallel corallites and extremely rare connecting tubules ; the epitheca is heavily lined with stereome which leaves free only the inner third of the corallite ; the rare tabulae developed in this free space are more or less horizontal.

Description.—The corallum is large and fasciculate. The corallites are long tubes about 2 mm. in diameter, distant, or sometimes coalescent,[2] parallel or slightly flexuous, and extremely rarely connected by transverse tubules. The epitheca is thick and is ornamented by growth rings and slight swellings and constrictions. Gem-



TEXT-FIGURE 6.
Syringopora syrinx Eth.
Viséan limestone of Crinoid Mt., Diglum Barmundoo Goldfield, near Gladstone, Queensland. G.S.Q. collection. Natural size.

(1) Lang and Smith MS.
(2) Mural pores have not been observed when two corallites are in contact.

mation is lateral. At the point of origin the new corallites, which issue either horizontally or inclined upwards, are usually about half the diameter of the parent ; they rapidly attain adult diameter and an upright growth.

The epitheca is lined internally by a thick deposit of stereome, which leaves free only the inner third of the tube. The septa are irregularly developed as vertical series of long spines which are embedded[1] in the stereome lining. The spines are presumably slightly inclined upwards, but the evidence on this point is not very clear ; sometimes their apices project into the free axial space. When perfectly developed, which is rare, the spines form twelve series. The narrow median free space is crossed at unequal wide intervals by unthickened tabulae, which may be horizontal, concave, convex, or irregular. No traces of infundibuliform tabulae have been seen in the stereome. The walls of the buds, and of the rare connecting processes are also lined by stereome. The connecting processes are devoid of tabulae.

Distribution.—In addition to the type locality, the species is known from the Upper Viséan Riverleigh limestone of Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland ; in Viséan limestones at Pal Lal, County Murchison, New South Wales, and Crinoid Mt., Diglum, Barmundoo Goldfield, near Gladstone, Queensland ; and from Lower Carboniferous calcareous sediments on Station Ck., Mt. Morgan, near Rockhampton, Queensland (F 1700, Queensland Museum collection).

Remarks.—In external appearance *S. syrinx* resembles *S. ramulosa* Goldfuss. But the thick lining of stereome and the extreme rarity of connecting tubules make the species very distinctive. It is possible that the inner free space of *S. syrinx* represents the syphon of typical *Syringopora*, and that the infundibuliform tabulae are masked in the Australian species by the thick stereome lining, as are the spiniform septa ; but no traces of such plates have been observed in the stereome.

Genus PALAEACIS Haime.

Palaeacis Haime, in H. M. Edwards 1857, p. 9, explication des Planches ; 1860, iii ; p. 171.

Genotype.—(by monotypy) *Palaeacis cuneiformis* Haime in H. M. Edwards 1857, p. 9 Atlas, explication des Planches, Pl. E 1, fig. 2 (a, b, c, d) ; 1860, iii, p. 171 ; from the Lower Carboniferous of Spurgen Hill (Indiana), U.S.A.

L. B. Smyth (1929) states (p. 125) that " the genus *Palaeacis* was founded in 1860 by Milne Edwards " ; and he also names Milne Edwards (p. 133) as the author of the type species, *P. cuneiformis*. But it is clear from Edwards' text that Haime was the author of the genus ; (" *Palaeacis*, Haime, note inédite " is given as the original reference). Therefore under Article 21 of the International Rules of Nomenclature[2] it should be referred to as *Palaeacis* Haime. Milne Edwards' statement, p. 171, " Nous donnerons ici la description de ces corps, qui nous a été remise par notre regretté collaborateur, peu de temps avant sa mort " is followed by the heading *Palaeacis cuneiformis*, and a description ; and although there are no quotation marks, it seems clear that Haime was the author of the specific name also in his note inédite. Also the genus should date from 1857, when the name and figures appeared in the Atlas.

(1) The course of the spines through the stereome may sometimes be traced in reflected light.

(2) C. W. Stiles 1926, p. 80. " The author of a scientific name is that person who first publishes the name in connection with an indication, a definition, or a description, unless it is clear from the contents of the publication that some other person is responsible for said name and its indication, definition, or description."

Smyth (loc. cit.) gives no diagnosis of the genus, and none is given here, since the minute structure of the type species is unknown, and may not be the same as that described for *P. axinoides* Smyth, although the ornament and occurrence of pores suggests that it is, and the two species are similar in form. Further it is uncertain whether the species *Hydnopora ? cyclostoma* Phillips which was placed in the genus *Palaeacis* by Etheridge and Nicholson (1878, p. 221), and in *Microcyathus* by Hinde (1896, p. 447), and also the species *P. humulis* Hinde, which differ in form from the type species, and in form and structure from *P. axinoides*, are to be included in the genus *Palaeacis*.

A few imperfect specimens which have been found in Queensland have an identical internal structure with that described by Smyth (loc. cit.) for *P. axinoides*, and if *P. axinoides* is correctly referred to *Palaeacis*, then the Queensland species is also.

Palaeacis sp. cf. cuneiformis Haime. (Plate V, figs. 40–41).

External form.—With one exception the Queensland specimens seem[1] to be keeled and wedge shaped, and very flat, like *P. cuneiformis* Haime. The exceptional specimen (Plate V, fig. 40), begins like the wedge shaped forms as a pyramid of narrow rectangular cross section, but continues upwards as a flattened prism. The calices are confined to the two narrower sides of the prism, and open directly outwards. The top of the specimen is broken off. In specimens with the normal semicircular margin, the calices are confined to this upper margin, where they are all in the one median plane, *i.e.*, in the plane of flattening (as in *P. cuneiformis*), with the possible exception of one calice partly hidden by matrix in the specimen figured Plate V, fig. 41. This latter is the largest wedge shaped specimen, and is 20 mm. broad and 6 mm. from surface to surface. The elongate specimen was 10 mm. broad, 5 mm. from surface to surface, and 25 mm. high.

The apertures of the corallites are oval ; in the largest one the longer diameter was 6 mm., and the shorter 3 mm. The calices are funnel shaped, and the sides are marked by longitudinal granular septal ridges ; the granules or spines are arranged in transverse rows. The sides are perforated by pores between the septal ridges.

The ornament of the outer surface of the corallum consists of fine, close set ridges, whose disposition is variable. Smyth's description (loc. cit. p. 127) of the ornament of *P. axinoides* applies exactly, and may be repeated. The ridges " may be fairly continuous for some distance. But more often they are broken into short lengths, or even consist of rows of granules. They may be fairly straight and parallel, or sinuous, or may form a labyrinthine pattern, or a chaotic field of granules and short ridges. A parallel arrangement often occurs near the margin of an aperture and at right angles to that margin, and in general is parallel to the axis of a corallite, and indicates its trend within the corallum. When parallel there are from 4 to 6 ridges in 1 mm." Pores occur between the ridges, but can only be seen in tangential section.

In thin section the calcareous tissue of the corallum is seen to be of two kinds, as in *P. axinoides* : the one forming the lining of the calice, and the other the rest of the corallum. The lining tissue is finely

(1) They are very imperfect.

fibrous at right angles to its surface. The tissue of the rest of the corallum consists of closely placed plates each pinnately fibrous, and each arranged at right angles to the surface. The surface ridges of the corallum are the surface traces of these plates, and the surface furrows represent the planes of contact of the plates.

A canal system pierces both tissues. The canals open at right angles to the surface into the pores of the calice floor and surface of the corallum, the pores of the lining tissue being larger. The canals become irregular in course shortly below the surface of the corallum, and are concentrated in the tissue between two calices. They are excavated equally from two contiguous plates, and are usually as thick as one plate.

Distribution.—Oolitic limestone (probably Upper Viséan) on Portion 193, Parish of Mundowran, County of Yarrol, near Mundubbera, Queensland; Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, Queensland; and—reported by Dr. Whitehouse, in Reid 1930, p. 32, as " Gen. et. sp. nov. (a new genus of corals of unknown affinities) "—from the top limestone of Portions 37 and 38, Parish of Cannindah, County of Yarrol, Queensland.

Remarks.—The structure of the Queensland individuals, their ornament and their granular septal ridges are identical with those of *P. axinoides* as described by Smyth ; but they differ from this species by their greater flatness, their oval calicular apertures which are arranged all in one plane, and their funnel shaped calical floors. In their flat shape, the arrangement of their calices and their ornament they resemble *P. cuneiformis.* The structure of the latter species is however unknown, and until it is the specific position of the Queensland specimens will not be clear. The very elongate Queensland individual may or may not belong to the same species as the keeled wedge-like ones ; further collecting will show the possible range of variation in shape. Some specimens of *P. cuneiformis* from the type locality are taller than they are broad.

Notes on the Ages of Coral bearing Limestones in the Lower Carboniferous (Dinantian) of Australia.

In Australia Lower Carboniferous marine (Dinantian) strata have been reported from the east coast Palaeozoic geosynclinal, and from the Kimberley district iu Western Australia. They are known only from a series of isolated outcrops, geological mapping being still in an early reconnaisance stage.

In the east these outcrops are included in a strip of country 60 to 90 miles wide which runs south east inland from St. Helens (lat. 21°) (*see* map) to Cannindah (lat. 25°) and south from Cannindah to Babbinboon (lat. 31°) whence it sweeps south south east again towards the coast near Port Stephens (lat. 33°). These marine strata are referred to the Rockhampton series in Queensland and to the Burindi series in New South Wales. The Rockhampton series in its type district is thought to be conformable with marine Upper Devonian (*vide infra*), but the Burindi series in its type locality is assumed to represent only the Upper Dinantian or Viséan, and succeeds without apparent unconformity a fresh water series with Upper Devonian—Lower Carboniferons plant remains known as the Barraba mudstones. The Burindi series is succeeded by terrestrial sediments, the Kuttung

TABLE I. THE LOWER CARBONIFEROUS OF EASTERN AUSTRALIA.

Age		Queensland (Rockhampton District)		New South Wales.	
Moscovian		Neerkol Series	Marine strata Mudstones with Dinantian-Moscovian brachiopods. Pebble conglomerate.	Kuttung Series	Terrestrial; Lavas and cgts with *Rhacopteris*, etc.
Dinantian	Viséan	Rockhampton Series	Lion Ck. limestone with D_2 coral fauna. Marine strata	Burindi Series	Marine calcareous shales, cherts and tuffs with occasional limestone; with corals and brachiopods.
	Tournaisian		Beds with *Protocanites* and *Pseudarietites*.	Barraba Series	Tournaisian and Upper Devonian mudstones with *Lepidodendron*, etc.
Devonian			Upper Devonian marine strata.		

(?Moscovian) series of volcanic rocks and sediments with a *Rhacopteris* flora. No rocks which might be referred with certainty to the Kuttung series are known above the Rockhampton series, but near Rockhampton mudstones and grits containing near the base brachiopods of an Upper Dinantian and Lower Moscovian type[1] are found immediately above the limestones which are taken as the top of the Rockhampton series. They are followed (relation uncertain) by the Dinner Ck. series of non-marine sediments which contain a *Glossopteris* flora probably of Uralian age.

The Rockhampton series is believed to be conformable with the Upper Devonian of the district since there are 5000–6000 ft. of strata (shales, cherts, grits, and pebble conglomerates, calcareous and often tuffaceous) below the Lion Ck. limestone (D_2 *vide infra*) striking along the same line as the Upper Devonian; and since the goniatites *Protocanites* and *Pseudarietites* characteristic of the basal zone of the European Carboniferous are recorded[2] from "Rockhampton District." The top of the Rockhampton series is taken at the base of a pebble conglomerate overlying this D_2 limestone. (Reid and Morton (1928, p. 386) postulate a non-sequence between the limestone and conglomerate and Reid (1930, p. 34) attempts to correlate with it certain strata occurring at Cannindah. This non-sequence is denied by Whitehouse (1928, p. 441) on the grounds that this particular pebble conglomerate is no coarser than others in the Rockhampton series, and that the brachiopod fauna of the mudstones and grits above it has Dinantian as well as Moscovian affinities. Reid's attempted correlation of 1725 ft. of strata at Cannindah with the postulated non-sequence is discussed below.)

Non-marine sediments which are probably Dinantian are known in Queensland from isolated outcrops west and north of the belt of marine Dinantian, and in the Drummond Ranges, Star R. basin, Herberton and Pascoe R. districts; these contain a *Lepidodendron* and *Rhacopteris* flora, with in one case (Star R. basin) *Phillipsia* sp. and brachiopods indicating a marine incursion.

The map appended shows the extent of these Carboniferous rocks, and the localities mentioned.

Age as determined by the corals.

The corals examined for this paper and the localities where they were collected are set forth in the accompanying table. They are all Viséan in character.

It is important to know the exact age of the Lion Ck. limestone, since it belongs to the type succession of the Rockhampton series. Etheridge (1900, p. 5) who first described its fauna, said the corals had a combined Carboniferous and Permo-Carboniferous facies, but Whitehouse (1928, p. 441) gave its horizon as D_2, and this horizon is also suggested by the present work. The Lion Ck. fauna contains no form which can fairly be used to fix its horizon to any zone smaller than the Viséan of the English succession, but more detailed correlation may be made through the larger fauna from Riverleigh.

(1) Determinations by Whitehouse (1928, p. 441). He uses the term Lower Carboniferous as synonymous with Dinantian, and Upper Carboniferous as meaning all Carboniferous above the Dinantian.

(2) Whitehouse MS quoted Reid 1930, p. 35.

At *Riverleigh*[1] the corals occur in a reef limestone above and below which olive shales occur. Three and half miles away, nearer to Mundubbera, a coarsely oolitic limestone contains *Palaeacis* sp. cf. *cuneiformis* Haime, a species of *Evactinopora* and two species of lamellibranchs ; but owing to faulting, prickly pear and alluvium its relation to the main and isolated Riverleigh horizon is unknown. The Riverleigh fauna can be correlated with a fair degree of precision with the D_2 fauna of England. The chief evidence for such a correlation is given by *Orionastraea lonsdaleoides* Hill and *Aulina simplex* Hill.

In England a species transitional between *Lithostrotion* Fleming and *Orionastraea* Smith (*O. ensifer* (Edwards and Haime),) appears in the D_2 zone, and is common there. *O. lonsdaleoides* is undoubtedly such a transitional species, and therefore suggests the D_2 zone. The genus *Aulina* Smith is represented in the north of England by a dendroid and an asteroid species, in limestones believed to be above the D_2 zone of the south of England, and as such referred to a D_3 zone, whose limits and relations are however very inaccurately known. A simple species of a genus must, since there is no known example of a compound form reverting to a simple state, be considered either on the same horizon as or earlier than compound species of the same genus. *A. simplex* this indicates a high D_2 horizon.

The rest of the Riverleigh fauna gives general support to this conclusion. *Symplectophyllum* Hill is a clisiophyllid genus whose variable axial structure is reminiscent of the D clisiophyllids of Scotland and the north of England. *Amygdalophyllum* Dun and Benson is without a representative in England unless it be the Upper Viséan *Koninckophyllum* Thomson. *Aphrophyllum* Smith also is not represented in England, but *Carcinophyllum patellum* Hill is very like C. *densum* Ryder from zone D_2. *Lithostrotion* is known throughout the Viséan, but according to Schindewolf (1928, p. 149) very incomplete tabulae such as characterise the Riverleigh species of the genus are diagnostic of the Upper Viséan of D zone. The tabulate corals do not assist in straightigraphical discussion. The whole fauna is thus undoubtedly Upper Viséan or D in type, while *O. lonsdaleoides* and *A. simplex* indicate that it may be more minutely placed as homotaxial with D_2.

Lion Ck. limestone fauna : By reason of its close similarity the Lion Ck. fauna may also be placed in D_2. It may be slightly earlier than the Riverleigh fauna, but there is not yet sufficient evidence for argument.

Mt. Grim and *Diglum* : Of these isolated fossiliferous limestones, we can only say that they are Viséan in age, probably Upper Viséan.

Texas : Since the sheared coral from Texas is probably *Lithostrotion* the possibility that the "Gympie" series of Texas contain Viséan strata must be considered.

Other Queensland Localities : In addition to the corals described above, some collected by J. H. Reid from three localities in the *Can-*

(1) This new coral locality on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland, was shown to me by Mr. F. Mischlewski, a local resident. I collected from it and made reconnaisance surveys first alone, then with a party from the University of Queensland, and later with Dr. Whitehouse. The results were not sufficient for publication, but maps with some details are placed in the University of Queensland Geology Department.

nindah district have been provisionally determined by Whitehouse as follows :—

(*a*) From Old Cannindah Homestead, near Monto (Whitehouse 1927, p. 189)

Syringopora syrinx Eth. fil.
Amygdalophyllum inopinatum Eth. fil.
Lithostrotion cf. *stanvellense* Eth. fil.
Cionodendron (?) sp.

(*b*) From Splinter Ck., por. 20, par. of Cannindah, 9 miles north of Old Cannindah Homestead (Whitehouse 1927, p. 189).

Syringopora syrinx Eth. fil., and *Lithostrotion stanvellense* Eth. fil.

(*c*) From the top limestone in pors. 37 and 38, par. Cannindah, 3 miles N.E. of (*b*). (Reid, 1930, p. 32).

Palaeosmilia aff. *retiformis* (Eth. fil.)
Gen. et sp. nov. (a new genus of corals of unknown affinities)[1].

From Cania Reid lists (1930, p. 35) Whitehouse's determinations

Cyathaxonia (?) sp.
Pleurophyllum spp. indet.
Lophophyllum (?) *corniculum* De Kon.

None of these corals have been sectioned, and although I was unable to obtain them for examination I consider that no reliance should be placed on the identifications. On this evidence Whitehouse assumed (1927, p. 189) that the limestones (*a*) and (*b*) were " plainly on the same stratigraphical horizon," that of the Lion Ck. limestone. So they may be, if the identifications are correct and the " stratigraphical horizon " be wide enough to include the whole of the Viséan ; for the only genus whose range is known is *Lithostrotion*, and it extends throughout the Viséan. Reid (1930, p. 34) finds his argument for a non-sequence between the Lion Ck. limestone and the overlying basal pebble bed of the Neerkol series strengthened by the exact correlation of (*a*) and (*b*) with the Lion Ck. limestone ; for he considers that 1725 ft. of strata above (*b*) in the Cannindah area, containing Dinantian (*fide* Whitehouse) brachiopods and, at (*c*) corals, have no representatives in the Stanwell section. But if (*b*) occurs towards the base of the Viséan, as is possible, while the Lion Ck. limestone is at the top, there would be room for missing strata between the two.

In *New South Wales* the isolated coralliferous localities (usually in impure or oolitic limestone) in the Burindi series of shales, cherts and tuffs, all contain very few species, and their stratigraphical relations to one another are unknown. In each case however the coral assemblage is unmistakably Viséan ; but one is not justified in arguing further. A few corals recorded in Benson's lists (1921, pp. 18–24) are not mentioned here since I was unable to examine them. A paratype of *Aulophyllum davidis* Eth. fil. (1891, p. 23) has been cut, however, and whatever else it is it is certainly not *Aulophyllum* Edwards and Haime. The specimens seem badly crushed and are probably referable to *Caninia* auctt.

(1) Dr. Whitehouse has since informed me that this is the same as the species described herein as *Palaeacis* sp. cf. *cuneiformis* Haime.

In *Western Australia* the Geikie and Rough Range series of the Kimberley are regarded as Viséan. David and Sussmilch (1931, p. 513 and fig. 3) list the series as unconformable with the Devonian and Permo-Carboniferous (Uralian), and report the occurrence in it at Price's Ck. of *Lithostrotion affine* and *Syringopora.* On writing for specimens however I was informed that they could not be traced. But the Geological Survey of Western Australia sent me a specimen from the Freney Oil Area, Kimberley, labelled *Lonsdaleia* aff. *floriformis* (Glauert 1925, p. 45). This has been cut and is not referable to *Lonsdaleia* M'Coy. It is probably a diphymorph of a cerioid *Lithostrotion,* but it is too crystalline for accurate determination.

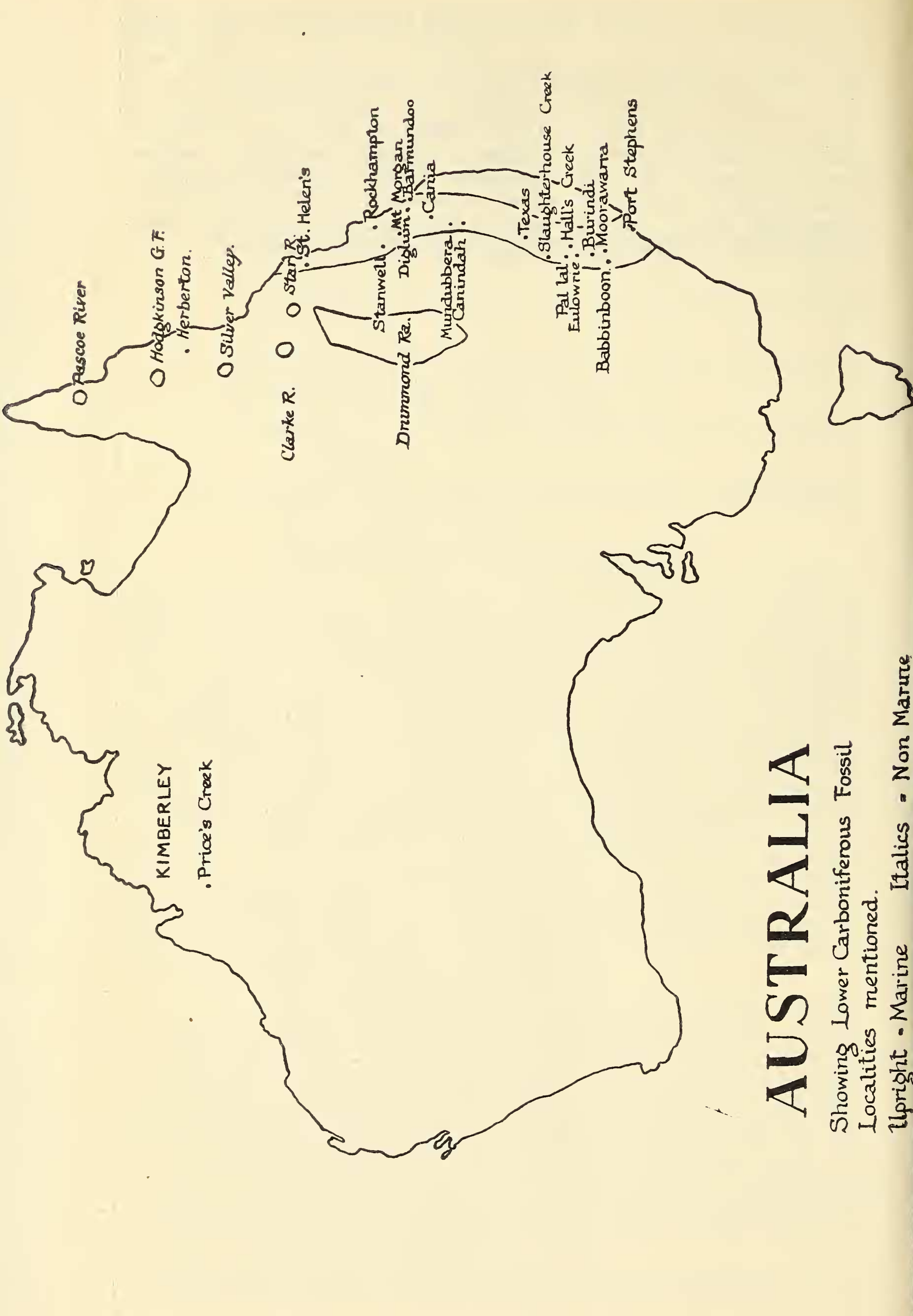

AUSTRALIA
Showing Lower Carboniferous Fossil Localities mentioned.
Upright • Marine Italics = Non Marine
KIMBERLEY
Price's Creek
Pascoe River
Hodgkinson G.F.
Herberton.
Silver Valley.
Clarke R.
Star R.
St. Helen's
Rockhampton
Stanwell
Drummond Ra.
Mt Morgan
Diglum
Baramundoo
Cania
Mundubbera
Canindah
Texas
Slaughterhouse Creek
Pal lal
Eulowrie
Hall's Creek
Burindi
Babbinboon
Moorawarra
Port Stephens

TABLE II.—SPECIES EXAMINED IN THIS PAPER, AND THEIR LOCALITIES.

X = common or fairly common. Numerals = number of specimens.

	Queensland (Rockhampton Series).							New South Wales (Burindi Series).						
	Latza's Farm, Por. 21 & 22 Par. of Malmoe, County of Yarrol, near Mundubbera) (Riverleigh limestone).	Por. 193, Par. Mundowran, County of Yarrol, near Mundubbera.	Lion Ck., Stanwell, near Rockhampton.	Station Ck., Mt. Morgan.	Mt. Grim., Gladstone Dist.	Crinoid Mt., Diglum, Bermundoo G.F. near Gladstone.	Texas.	Babbinboon	Parish of Hall, 16 miles south of Bingara.	Quarry at Taree.	Horton R., between Eulowrie and Pal Lal.	Near Police Station, Horton R.	Moorawarra, Somerton.	Slaughterhouse Ck., near Gravesend.
Symplectophyllum mutatum Hill	X		—											
Amygdalophyllum etheridgei Dun & Benson	—		—					X						
A. inopinatum (Eth. fils).	X		X											
A. conicum Hill	X		—											
A. sp. near conicum	1		—											
A. vallum Hill	2		—											
Aphrophyllum hallense Smith	—		—						X	X				
A foliaceum Hill	X		3											
Carcinophyllum patellum Hill	X		—											
Lithostrotion columnare Eth. fils. ..	X		X								X			
L. stanvellense Eth. fils.	X		X			X			X					
L. arundineum Eth. fils.	—		X		1	X	?				X	X		
(Diphyphyllum) sp.	—		—										X	
(Diphystrotion) mutabile Hill	—		1											
Cionodendron columen Smith	—		—										1	X
Orionastraea lonsdaleoides Hill	X		—											
Aulina simplex Hill	X		—											
Michelinia dendroides Hill	X		—											
M. sp.	—		2											
Syringopora syrinx Eth. fils.	X		X	1		X					X			
Palaeacis sp. cf. cuneiformis Haime ..	—	X	1											

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EXPLANATION OF PLATES.

PLATE VII.

Symplectophyllum mutatum sp. nov. from the Upper Viséan Riverleigh Limestone of Latza's Farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Specimens and slides in the University of Queensland Collection.

All figures natural size.

Figs. 1 – 6. Sections from holotype F 2943. Septal lamellae few and discontinuous, and stereome scanty. At A note point of insertion of new septa (*see* p. 7). Fig. 4 shows a large root process. The Median Vertical Sections show the haphazard occurrence of complete and incomplete tabulae and stereoplasmid and non-stereoplasmid horizons.

Figs. 7 – 9. Sections from F 2946. Septal lamellae more numerous and twisted, with more stereome.

Figs. 10–11. Sections from F 2385. A faulted specimen. The pseudo fossula at B is due to injury. Stereome scanty. Note the rings of dissepiments. *See* also figs. 31–33.

Figs. 12–13. Sections from F 2454. Very open axial structure. At C traces of trabeculae in vertical section of septa.

Fig. 14. Transverse section from F 2959. Non-stereoplasmid axial structure with twisted but discontinuous axial lamellae. Both types of septal modification well shown. Part of this specimen is A 5470 in the Sedgwick Museum.

Fig. 15. Tr.S. from F 2451. Dibunophylloid axial structure.

Figs. 16–19. Tr. sections from F 2947. Dibunophylloid axial structure lost in highest section fig. 19.

Fig. 20. Tr.S. from F 2512. Stereome abundant, septal structure well shown.

Figs. 21–23. Sections from F 2511. Stereome abundant, variable in amount.

Fig. 24. Tr.S. from F 2514. Stereome abundant.

Fig. 25. M.V.S. from F 2499. Stereome abundant.

Fig. 26. Tr.S. from F 2489. Stereome abundant, septal lamellae numerous, continuous and twisted. *See* figs. 29 and 30.

Fig. 27. Tr.S. from young stage of F 2948, a stereoplasmid corallite.

Fig. 28. Part of fig. 20 to show the septal modifications in Tr. S.

Fig. 29. Tangential V.S. through the peripheral series of transverse plates between the points D and E in fig. 26.

Fig. 30. Tangential V.S. through the median cavernous parts of the septa between the points F and G in fig. 26.

Figs. 31–33. Tangential V.Ss. between the points H and J, K and L, M and N, respectively in fig. 10, to show details in the arrangement of the peripheral series of transverse plates.

PLATE VIII.

Amygdalophyllum from the Upper Viséan Riverleigh limestone of Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Specimens and slides in the University of Queensland collection.

All figures natural size.

Figs. 1 – 3. *A. inopinatum* (Etheridge fil.). Sections from F 2949. Fig. 1 is from lower stage than fig. 2; note in it the septa dilated in the tabulate area, and the withdrawal of the minor septa from the periphery. Neither of these characters appear in fig. 2.

Fig. 4. *A. inopinatum.* Tr.S. from F 2491. Note *Naos* septal modification and peripheral withdrawal of the septa. Part of this specimen is A 5065 in the Sedgwick Museum.

Fig. 5. *A. inopinatum.* Tr.S. from F 2493. Dilated septa thinning peripherally.

Fig. 6 *A. inopinatum.* Tr.S. from F 2384. A small specimen.

Figs. 7 – 8. *A. inopinatum.* Sections from F 2482. Note basal outgrowth for attachment in fig. 8.

Fig. 9 – 11. *A. vallum* sp. nov. Sections from the holotype F 2950. Note traces of the formation of the columella from the tabulae in fig. 10.

Figs. 12–13. *A. vallum.* Sections from paratype F 2453. Fig. 12 is taken through the bottom of the calyx.

Figs. 14–21. *A. conicum* sp. nov. Serial sections from the holotype F 2951. Note septa withdrawn from aixs in fig. 17 and from periphery in figs. 18 and 21.

Figs. 22–31. *A. conicum.* Serial sections from paratype F 2437. Note peripheral withdrawal of septa. Fig. 22 is from a very thick section; fig. 25 shows a slight development of the *Naos* trend, and fig. 28 a slight axial withdrawal of the septa.

Figs. 32–33. *A. conicum.* Sections from paratype F 2498 showing dilation and peripheral withdrawal of the septa.
Figs. 34–36. *A. conicum.* Sections from paratype F 2436.
Figs. 37–40. *A. conicum.* Sections from paratype F 2445 showing peripheral dilation of the septa. Fig. 40 is through the calyx.
Figs. 41–48. *A. conicum.* Sections from paratype F 2942 showing the *Naos* trend well developed. Figs. 47–48 are calical.
Figs. 49–50. *A. sp. near conicum.* Sections from F 2449.

PLATE IX.

All figures natural size. Except where otherwise indicated specimens and slides are in the University of Queensland collection.

Figs. 1 – 2. *Amygdalophyllum inopinatum* (Etheridge fil.), a diseased individual F 2465 from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. *See* p. 32.
Figs. 3 – 4. *Aphrophyllum hallense* Smith. Sections from F2953 from the Viséan Burindi limestones of the Parish of Hall, 16 miles south of Bingara, New South Wales. Note the *Naos*-like modification of the septa.
Fig. 5. *A. hallense.* R 29634, British Museum, from the Viséan Burindi limestones, Quarry at Taree, New South Wales.
Figs. 6 – 8. *Aphrophyllum foliaceum* sp. nov. Sections from F 2954 from the Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, Q. Figs 6 and 8 are the upper and lower surfaces respectively of fig. 7. Note paliform lobes (?) axial structure, and *Naos* septal modification.
Fig. 9. *A. foliaceum.* Section along lower surface of fig. 16, from paratype F 2955, from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland. Most of the peripheral zone of dissepiments is destroyed.
Fig. 10. *A. foliaceum.* Tr.S. from F 2536. Horizon and Locality as for figs. 6–8. Note septal dilation and plaiform lobes (?). Periphery destroyed.
Fig. 11. *A. foliaceum.* Tr.S. from young stage of paratype F 2956.
Fig. 12. *A. foliaceum.* Tr.S. from paratype F 2957. Peripheral zone of dissepiments partly preserved. Note uneven septal dilation and length of minor septa.
Figs. 13–14. *A. foliaceum.* Sections from paratype F 2502.
Fig. 15. *A. foliaceum.* Tr.S. from paratype F 2958. Most of the peripheral zone of dissepiments destroyed.
Fig. 16. *A. foliaceum.* M.V.S. from paratype F 2955. *See* fig. 9.
Figs. 17–19. "*Chonophyllum perfoliatum*" auctt. Tr.S., M.V.S., and Tg. V.S. respectively. A 5495b-d Sedgwick Museum. from the Middle Devonian, of Ramsleigh Quarry, Torquay, Devon, showing well developed *Naos* modification of the septa.

PLATE X.

All figures natural size. Except where otherwise indicated specimens and slides are in the University of Queensland collection.

Figs. 1 – 2. *Carcinophyllum patellum* sp. nov. External view and Tr.S. of the holotype F 2534 from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland.
Figs. 3 – 4. *C. patellum.* Sections from paratype F 2386.
Fig. 5. *C. patellum.* Tr.S. from paratype F 2432. Note budding.
Figs. 6 – 7. *C. patellum.* Sections from paratype F 2505, a very stereoplasmid individual.
Figs. 8–11. *C. patellum.* Sections from paratype F 2960. Note the lonsdaleoid dissepiments.
Figs. 12–13. *C. patellum.* Tr.Ss. from paratype F 2961.
Figs. 14–17. *C. patellum.* Sections from paratype F 2460, a less stereoplasmid individual.
Fig. 18 *Lithostrotion columnare* Etheridge fil. Tr.S. from topotype, A 5493 in the Sedgwick Museum, from the Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, Queensland, showing typical aspect.
Fig. 19. *L. columnare.* M.V.S. from topotype F 2962, showing typical aspect.
Fig. 20 *L. columnare.* M.V.S. from topotype F 2538, showing tabellae in two series.

Figs. 21–22. *L. columnare.* Sections from F 2521 from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Queensland, showing aspect typical of this locality.

Fig. 23. *L. columnare.* Tr.S. A.M. 331 from F 6543 in the Australian Museum, from the Viséan limestone of the Horton R., between Eulowrie and Pal Lal, New South Wales, showing septa withdrawing from the periphery.

Fig. 24 *L. columnare.* M.V.S. A.M. 186 from F 6541 in the Australian Museum; horizon and locality as for fig. 23. Shows typical incomplete tabulae in two series.

Fig. 25. *L. columnare.* Tr.S. from topotype F 2962 (*see* fig. 19) showing disappearance of epitheca between corallites.

Fig. 26. *Lithostrotion stanvellense* Etheridge fil. Tr.S. from F 2963; horizon and locality as for figs. 21–22, showing septa typically in contact with the columella.

Fig. 27. *L. stanvellense* . Tr.S. A 5061 in the Sedgwick Museum; horizon and locality as for figs. 21–22. Septa not confluent with columella, and individual of large size.

Fig. 28. *L. stanvellense.* Tr.S. from F 2391; horizon and locality as for figs. 21–22. Bud and parent have a common epitheca.

Fig. 29. *L. stanvellense.* M.V.S. from F 2964; horizon and locality as for figs. 21–22. Shows typical incomplete tabulae.

Fig. 30. *L. stanvellense.* M.V.S. from large phaceloid corallum F 2383; horizon and locality as for figs. 21–22; fig. 27 is also from this corallum.

Fig. 31. *L. stanvellense.* Tr.S. from F 2965; horizon and locality as for figs. 21–22; note the beginning of the diphyphylloid trend in the withdrawal of the septa from the axis, and the associated parricidal gemmation.

Figs. 32–33. *L. stanvellense.* Sections F 2966, from the Viséan Burindi limestone of Hall's Ck., Parish of Hall, near Bingara, N.S.W. Shows much, stereome.

Figs. 34–35. *Lithostrotion arundineum* Etheridge fil. Sections from topotype F 2967; horizon and locality as for fig. 18; shows septa both confluent with and withdrawn from the columella, and tabellae in two series.

Fig. 36. *L. arundineum.* Tr.S. A.M. 184 from F 6546 in the Australian Museum, from the Viséan Burindi limestone near Eulowrie, N.S.W. Note peripheral withdrawl of minor septa.

Figs. 37–38. *L. arundineum* near *Cionodendron columen* Benson and Smith. Sections A.M. 565 from F 6544 in the Australian Museum; horizon and locality as for fig. 23. Note the dilation of septa and columella. Tabulae as in *L. arundineum.*

Figs. 39–40. *Ciondendron columen* Benson and Smith. Sections in the possession of Dr. Stanley Smith from the holotype; from Viséan Burindi limestones at Slaughterhouse Ck., near Gravesend, N.S.W.

PLATE XI.

All figures except 19–29 natural size. Except where otherwise stated, specimens and slides are in the University of Queensland collection.

Figs. 1 – 2. *Lithostrotion* sp. (*Diphyphyllum* sp.). Sections A 5494 in the Sedgwick Museum, from specimen 4510 (or 4515) in the collection of the Geological Survey of New South Wales, from the Viséan Burindi limestone of the Parish of Moorawarra, near Somerton, N.S.W.

Figs. 3 – 4. *Lithostrotion* sp. (*Diphystrotion mutabile* sp. nov.) Sections from the holotype F 2387 from the Upper Viséan Lion Ck. limestone, Stanwell, near Rockhampton, Q. Note the sporadic nature of the variation.

Fig. 5. *Orionastraea lonsdaleoides* sp. nov. Weathered aspect of paratype F 2529 from the Upper Viséan Riverleigh limestone on Latza's farm, Portions 21 and 22, Parish of Malmoe, County of Yarrol, near Mundubbera, Q.

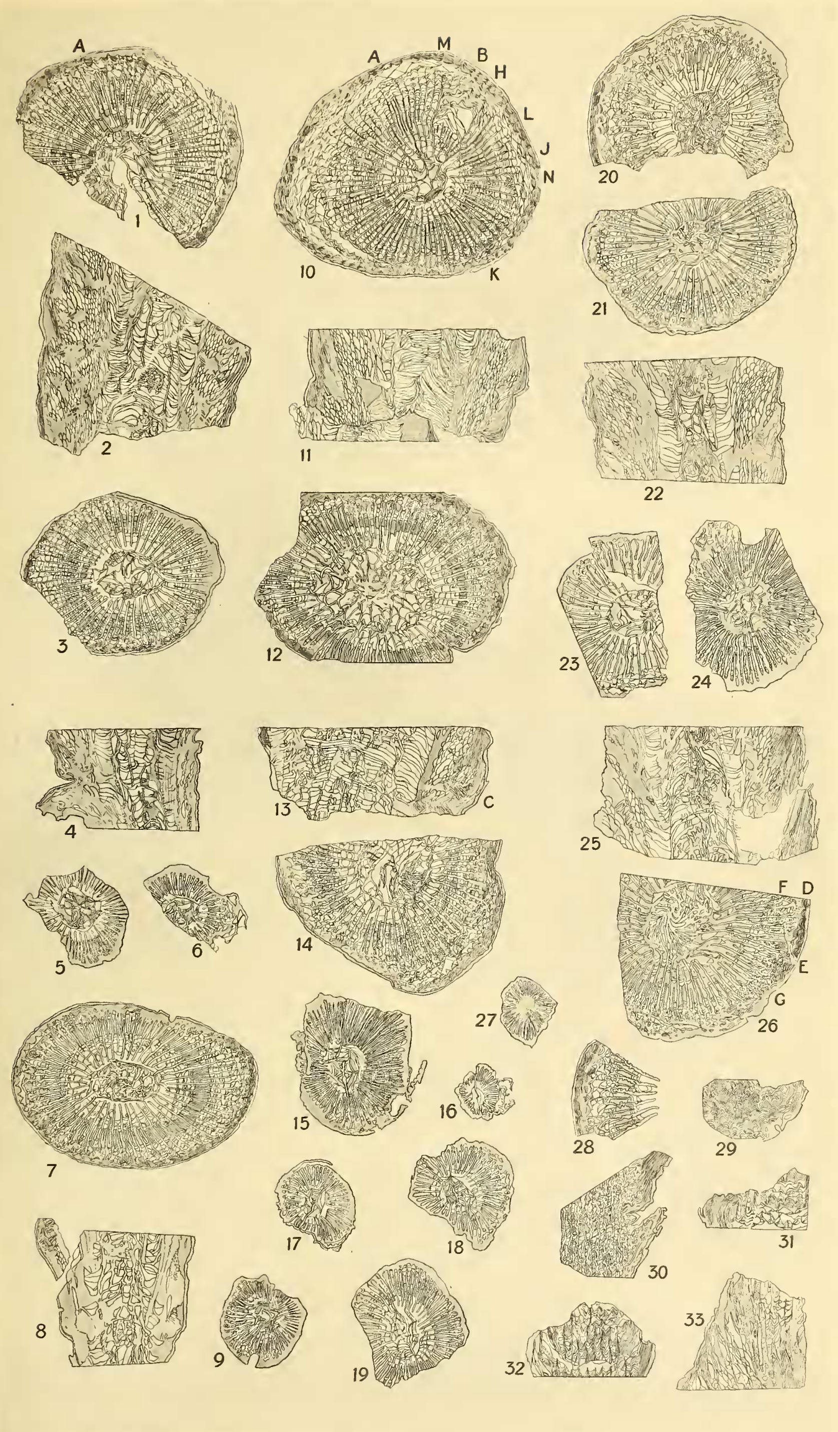
Figs. 6 – 8. *O. lonsdaleoides.* Sections from the holotype F 2938; notefrequent weak columella and rare extension of septa to periphery. Specimen partly macerated.

Fig. 9. *O. lonsdaleoides.* V.S. from paratype F 2533.

Figs. 10–11. *O. lonsdaleoides.* Sections from paratype F 2524. Specimen transitional from *Lithostrotion columnare* Eth. Note relics of epitheca and columella.

Fig. 12. *Aulina simplex* sp. nov. M.V.S. from paratype A 5488 in the Sedgwick Museum; horizon and locality as for fig. 5; note rare dissepiments.

Figs. 13–29. *A. simplex.* Sections from holotype F 2939; figs. 19–29 ×2 diameters; fig. 14 shows weak expression of londsdaleoid trend, and figs. 21–27 a root process.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